Report No. FAA-RD-76-64

COLLECTION OF COMMERCIAL AIRCRAFT CHARACTERISTICS FOR STUDY OF RUNWAY ROUGHNESS

Anthony G. Gerardi

Final Report

May 1977

Document is available to the U.S. public through
the National Technical Information Service,
Springfield, Virginia 22161.

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Systems Research & Development Service
Washington, D.C. 20590

Best
Available
Copy

NOTICE

Technical Report Documentation Page

1. Report No. FAA-RD-76-64	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Collection of Commercial Aircraft Characteristics for Study of Runway Roughness		5. Report Date May 1977
		6. Performing Organization Code
7. Author(s) Anthony G. Gerardi		8. Performing Organization Report No. AFCEC-TR-75-23
9. Performing Organization Name and Address Air Force Flight Dynamics Laboratory Wright-Patterson AFB OH 45433		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DOT-FA73WAI-361
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration 2100 Second Street, S.W. Washington, D.C. 20590		13. Type of Report and Period Covered Final Report
		14. Sponsoring Agency Code ARD-430

15. Supplementary Notes

Monitoring Agency: Air Force Civil Engineering Center, Tyndall AFB FL 32403

16. Abstract

Engineering data compatable with the computer program "TAXI" (Ref. 1) has been collected for six commercial jet aircraft: These are the Boeing 707-320C, 727-200, and 747 and the McDonnell Douglas DC-8-63, DC-9-40 and the DC-10-10. The data presented in the form required by "TAXI". A simulation was made for each aircraft taking off from two separate airfields, Dulles International in Washington D.C. and Will Rogers International Airport at Oklahoma City, Oklahoma. The purpose of using two profiles being to point out the differences in aircraft response to different runway profiles. The calcomp plotted results are presented in the results section of this report.

This report also serves as a program users manual. A sample problem simulating a Boeing 707-320C during a constant speed taxi (100 feet per second) over the profile at the Will Rogers International Airport is included in the report. All of the fortran symbols used in "TAXI" are defined, and a complete listing of the program is contained in appendices A, B, C, and D. Appendix E contains airplane data representing a "Typical" wide body tri-jet transport and two simulations using this data.

17. Key Words	18. Distribution Statement
Runway Roughness Roughness Aircraft Response Runway Irregularities Airfield Pavement	This report is available through the National Technical Information Service, Springfield, VA. 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	137	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS

Symbol	Definition	Unit
A	Distance from rear main landing gear to aircraft CG	..
a_1, a_2, a_3, a_4	Coefficients calculated to fit a polynomial curve to a runway segment	ND
A_h	Hydraulic piston area	in^2
A_o	Effective orifice area	in^2
B	Distance from nose landing gear to aircraft CG	in
C	Distance from front main landing gear to aircraft CC	in
c	Damping coeffifient	1/sec
C_d	Orifice coefficient	ND
F_A	Pneumatic strut force	lbs
F_{AD}	Total airplane aerodynamic drag	lbs
F_D, F_N	Landing Gear Drag and Normal Forces	lbs
F_F	Friction force	lbs
F_{F_n}	Strut seal friction	lbs
F_h	Hydraulic strut force	lbs
F_{s1}, F_{s2}, F_{s3}	Total landing gear strut forces	lbs
$F_t, F_{t1}, F_{t2}, F_{t3}$	Landing gear tire forces	lbs
F_T	Total airplane thrust	lbs
F_{TD}	Main landing gear tire drag force	lbs
F_u, F_L	Strut bearing friction forces, upper and lower	lbs
g	Gravitational acceleration constant	in/sec^2
I_{yy}	Total airplane pitching inertia	$lbs/in\ sec^2$
k	Linear tire spring constant	lbs/in

Symbol	Definition	Unit
M_1, M_2, M_3	$W_{1/g}, W_{2/g}, W_{3/g}$	sligs
L	Total airplane lift	lbs
M_{cg}	Airplane mass	sligs
M_i	The generalized mass for the ith mode	$lbs\text{-}sec^2/in$
P	Fully extended strut air pressure	lb/in^2
q	Deflection due to bending	in
q_i	Array of nondimensional time dependent coordinates which weigh the amount of motion due to the ith mode in the total motion of the aircraft	ND
$\dot{q}_i$	Time derivative of q_i	1/sec
$\ddot{q}_1$	Time derivative of $\dot{q}_i$	$1/sec^2$
S	Strut displacement	in
$\dot{S}$	Time derivative of S	in/sec
$\ddot{S}$	Second time derivative of $\dot{S}$	in/sec^2
Δt	Taylor series sample solution time step size	sec
T_D	Tire deflection	in
V	Fully extended strut volume	in^3
W	Total airplane weight	lbs
W_1, W_2, W_3	Unsprung landing gear weights	lbs
x	Coordinate for sample Taylor series solution	in
$\dot{x}$	Time derivative of x	in/sec
$\ddot{x}$	Time derivative of $\dot{x}$	in/sec^2
X	Horizontal translation of the aircraft down the runway	ft
$\dot{X}$	Time derivative of X	ft/sec
$\ddot{X}$	Time derivative of $\dot{X}$	ft/sec^2
Z	Vertical displacement of the vehicle CG	in
$\dot{Z}$	Time derivative of Z	in/sec

Symbol	Definition	Unit
$\ddot{Z}$	Time derivative of $\dot{Z}$	in/sec^2
Z_1, Z_2, Z_3	Vertical displacement of the unsprung mass of gear number 1, 2 and 3	in
$\dot{Z}_1, \dot{Z}_2, \dot{Z}_3$	Time derivative of Z_1, Z_2, Z_3	in/sec
$\ddot{Z}_1, \ddot{Z}_2, \ddot{Z}_3$	Time derivative of $\dot{Z}_1, \dot{Z}_2, \dot{Z}_3$	in/sec^2
ε_1	Distance from main gear axle to the waterline of the aircraft CG	in
$\xi_{i1}, \xi_{i2}, \xi_{i3}$	Modal deflection of the ith mode at gear 1, 2 and 3	in
θ	Aircraft pitch angle	rad
$\dot{\theta}$	Time derivative of θ	rad/sec
$\ddot{\theta}$	Time derivative of $\dot{\theta}$	rad/sec^2
ρ_h	Hydraulic fluid density	sligs/in^3
ζ_i	Percent of critical damping factor for the ith mode	ND
μ_L μ_u	Sliding coefficients of friction for strut lower and upper bearings	ND
ω_i	Natural frequency of the ith mode	rad/sec

SECTION I

INTRODUCTION

Very early aircraft operated from grass airfields or graded and untreated runways. However, with the development of more sophisticated aircraft requiring higher and higher ground speeds, runway surfacing became of increasing concern. Today's modern aircraft require a pavement system structurally capable of supporting gross loads approaching a million pounds. In addition, the pavement surface must provide adequate skid resistance and must be of sufficient smoothness to prevent undue loss of fatigue life in the aircraft. The response of aircraft to the pavement irregularities has become of increasing concern in recent years. A great deal of emphasis has been placed upon the comfort and safety of aircraft ground operations and other factors related to the interaction between the pavement and the aircraft.

Because the runway and the aircraft form a coupled system with the pavement profile providing a displacement input that can radically affect the behavior of the vehicle, there is an urgent need for a means to measure pavement roughness. The Federal Aviation Administration has long been aware of this need, and in 1973 initiated research and development efforts to quantify pavement roughness. This effort began with the study of a means for rapidly collecting the runway profile. As a result of that effort, a profiling system using a laser beam as a horizontal reference datum was developed (Reference 1).

The next step was to establish roughness criteria. Considerable effort had been expended in this area, most of it dealing with the subjective rating of ride quality. However, ride quality did not deal directly with the pavement, which was the factor causing unacceptable aircraft response. Therefore, in its efforts to define runway roughness, a statistical approach to the runway profile itself was taken (Reference 2). This approach dealt with the root means square of the deviation of the profile about a normalized line. From this comes criteria for evaluating a runway profile as being acceptable as long as the RMS level is below 0.32 inches. Marginal conditions are equated to RMS levels of 0.32 to 0.36 inches and any runway having a RMS level of greater than 0.36 inches is considered to be unduly rough.

As a check of this criteria and as a means of evaluating the simulated repair of a runway having undesirable roughness, an existing taxi code developed for the US Air Force was modified to provide a way for calculating the dynamic response of commercial aircraft to runway irregularities. The modification of that computer code is the subject of this report. The use of this computer program is not to compare ride

quality between various classes of aircraft but rather to be used by the operating airlines and airport owners and operators as a means of identifying rough pavement areas and to help insure the timely maintenance of pavements in order to prevent the development of undue roughness.

Details of the development of the computer code modified in this report is provided in Reference 3. The development of the computer code is only briefly summarized in this report. In order to make the computer code useful to all commercial aircraft, these aircraft were divided into five classes based on gross weight as shown below:

Aircraft Classes

Class	Weight Group
Class A Aircraft	Less than 150,000 pounds
Class B Aircraft	150,000 - 300,000 pounds
Class C Aircraft	300,000 - 450,000 pounds
Class D Aircraft	450,000 - 600,000 pounds
Class E Aircraft	Greater than 600,000 pounds

SECTION II

MATHEMATICAL MODEL

The general airplane/runway mathematical model used for this study was the basic mathematical model developed in Reference 1. A detailed description of the components that make up this general model, as well as the assumptions made are shown in Reference 1. This report presents, in summary form, the landing gear strut and tire representation, the airplane rigid body and flexible body representation, the runway profile representation, the equations of motion and the solution technique.

The general model is represented as a symmetrical body with either a nose and single strut main landing gear typical of class A through D aircraft. Each landing gear strut is assumed to have point contact with the profile and it is assumed that the main landing gear traverses the same profile as the nose landing gear except at a later time. The model has aerodynamic lift and drag and thrust applied at the aircraft's center of gravity.

The fuselage is free to pitch, plunge and translate horizontally down the runway. In addition to these rigid body degrees of freedom, up to 15 flexible modes of vibration are included. This fuselage motion is controlled by the landing gear strut forces, lift, drag, thrust, and the resisting parameters of aircraft mass and inertia. Figure 1 is a schematic drawing of the mathematical model used for this simulation.

The landing gear struts are non-linear, single acting oleo-pneumatic energy absorbing devices (Figure 2) and are represented in the model as the sum of the three forces, penumatic, hydraulic, and strut bearing friction forces. The pneumatic force, which is the largest of the three is represented by the equation:

$$F_a = \frac{PV}{\frac{V-S}{A}} \qquad (1)$$

where:

F_a = pneumatic strut force

P = the fully extended strut pressure

V = the fully extended strut volume

A = the pneumatic piston area

S = strut stroke

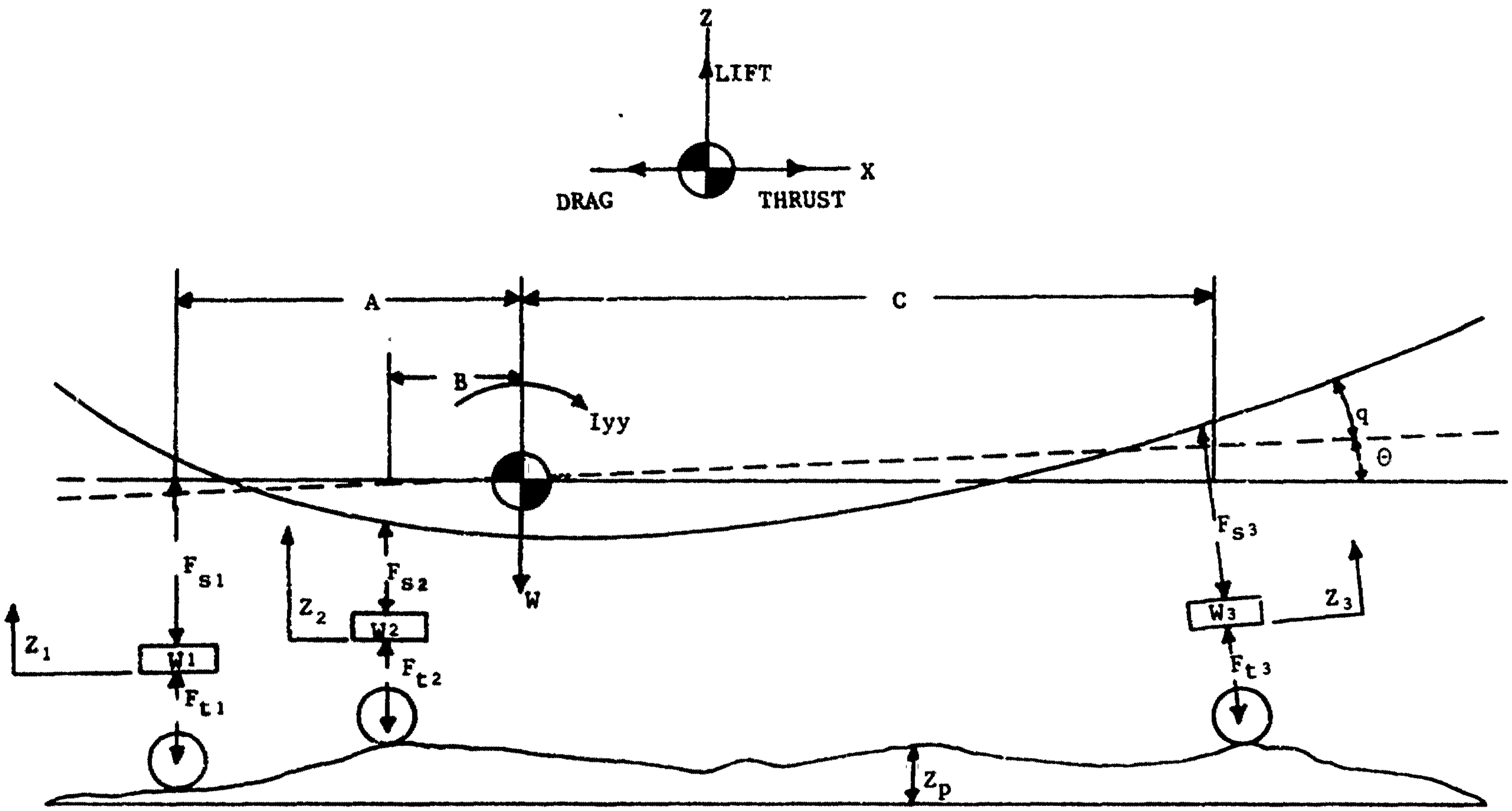


Figure 1 - Mathematical Model used in TAXI Simulation

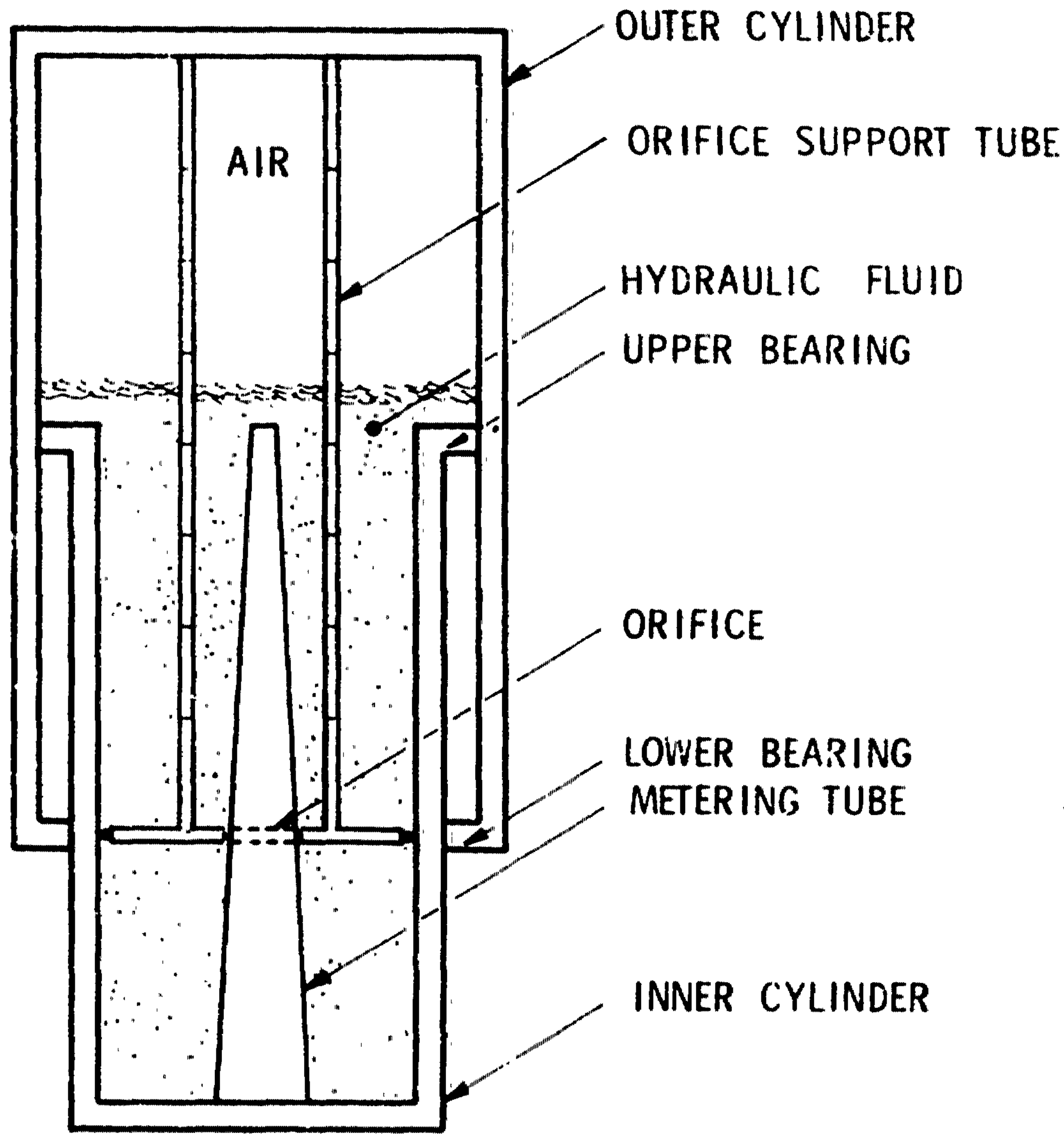


Figure 2. Typical Single Acting Oleo-Pneumatic Landing Gear Strut

The hydraulic or damping force is given by the equation:

$$F_h = \frac{P_h \, A_h^{\,3} \, \dot{S}|\dot{S}|}{2 \, (C_d \, A_o)^2}. \qquad (2)$$

where:

F_h = hydraulic strut force

P_h = density of the hydraulic fluid

A_h = the hydraulic piston area

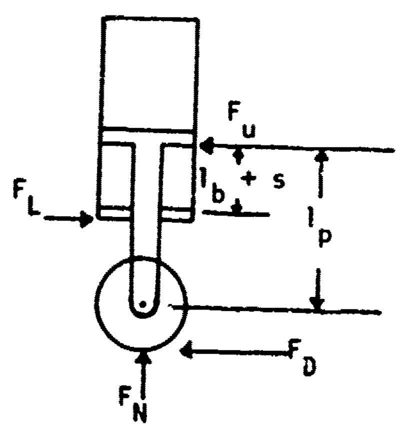
A_o = effective orifice area (constant orifice minus metering pin area)

C_d = orifice coefficient (use 0.9)

$\dot{S}$ = strut piston velocity

The third strut force is the strut bearing friction force and is included in the model only when articulated or asymmetrically loaded struts are being simulated. In symmetrically loaded struts the friction force is neglected (see Reference 1). The following derivation of the friction force was taken from Reference 2.

The force on upper and lower strut bearings due to rolling friction is shown in Figure 3:



$$F_{D_1} = .025 \, F_N$$

$$F_{u1} = F_{D1} \left(\frac{l_p}{l_b + s} - 1 \right)$$

$$F_{L1} = F_{D1} \left(\frac{l_p}{l_b + s} \right)$$

Figure 3. Friction Force Due to Wheel Drag

where:

F_D = landing gear drag force

F_N = landing gear normal force

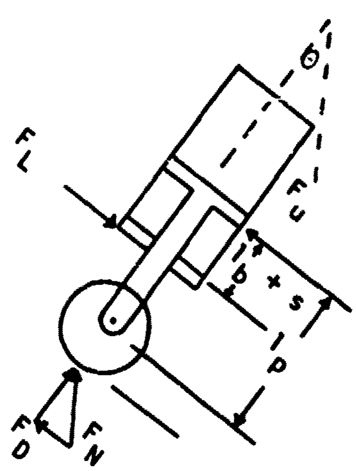
F_u, F_L = bearing forces at the upper and lower bearings respectively required to balance the lateral loading on the piston

l_p = the piston length

l_b = the strut fully extended bearing separation

s = the strut stroke

The force on upper and lower strut bearings due to nonperpendicular orientation is represented by Figure 4:



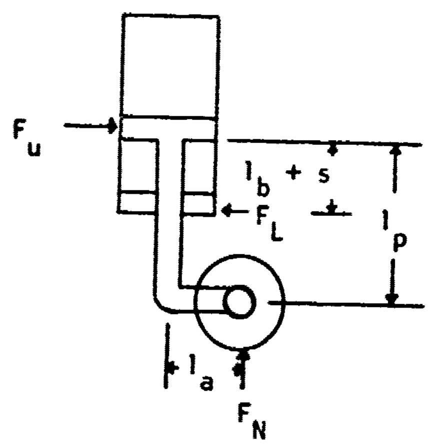
$$FD_2 = \sin F_N$$

$$F_{u2} = FD_2\left(\frac{l_p}{l_b + s} - 1\right)$$

$$F_{L2} = FD_2\left(\frac{l_p}{l_b + s}\right)$$

Figure 4. Friction Force Due to Nonperpendicular Orientation

Finally, as represented in Figure 5, the force on the upper and lower strut bearings due to axle offset is:



$$F_{u3} = F_{L3} = \frac{F_N \, la}{(l_b + s)}$$

Figure 5. Friction Force Due to Axle Offset

For a landing gear strut having wheel drag, an angle from the vertical and an axle offset, the total friction force would be as follows:

$$F_u = F_{u1} + F_{u2} + F_{u3}$$

$$F_L = F_{L1} + F_{L2} \pm F_{L3}$$

$$F_F = [\mu_L F_L + \mu_u F_u + F_{Fo}] \frac{|\dot{s}|}{\dot{s}}$$

where:

F_f = friction force

μ_u, μ_L = coefficients of sliding friction at the upper and lower bearings, respectively; $\mu_u = 0.10$, $\mu_L = 0.15$

(The lower bearing is generally not as well lubricated as the upper bearing.)

F_{F_o} = strut seal friction at zero lateral loading

The tire force is represented by the linear equation

$$F_t = k\ T_D \tag{3}$$

where:

F_t = tire force

T_D = tire deflection

k = linear tire spring constant

The runway elevation data is input into the model in two-foot increments, three data points at a time for each landing gear as required. The profile is made continuous by fitting the following polynomial through the three elevation data points and the slope at the end of the previous profile segment:

$$Y(x) = a_1 + a_2x + a_3x^2 + a_4x^3 \tag{4}$$

where:

$a_{1,2,3,4}$ = coefficients derived from the elevation and slope data

SECTION III

EQUATIONS OF MOTION AND SOLUTION TECHNIQUE

Equations of Motion:

The differential equations of motion for the mathematical model were derived by application of Hamilton's principle of minimum energy. The general form of these equations is shown below and corresponds to the notation shown in Figure 1.

<u>Rigid Body Equations of Motion</u>

$$\ddot{Z} = (F_{s1} + F_{s2} + F_{s3} + L - W)/M_{cg} \quad \text{[c.g., vertical acceleration]} \tag{5}$$

$$\ddot{Z}_1 = (F_{t1} - F_{s1} - W_1)/M_1 \tag{6}$$

$$\ddot{Z}_2 = (F_{t2} - F_{s2} - W_2)/M_2 \quad \text{[unsprung landing gear mass acceleration]} \tag{7}$$

$$\ddot{Z}_3 = (F_{t3} - F_{s3} - W_3)/M_3 \tag{8}$$

$$\ddot{\theta} = (F_{s1} A + F_{s2} B + F_{TD}\varepsilon_1 - F_{s3} C)/I_{yy} \quad \text{[pitching acceleration]} \tag{9}$$

$$\ddot{X} = (F_T - F_{TD} - F_{AD})/(12M_{cg}) \quad \text{[horizontal translation acceleration]} \tag{10}$$

where:

F_{s1}, F_{s2}, F_{s3} = total landing gear strut forces

F_{t1}, F_{t2}, F_{t3} = tire forces

M_{cg}, W, I_{yy} = aircraft mass, weight and pitching inertia

W_1, W_2, W_3 = unsprung landing gear weights

$A, B, \varepsilon_1,$ = moment arms

L, F_T, F_{TD}, F_{AD} = lift, thrust and tire and aerodynamic drag forces

d F_{AD} act through the center of gravity]

Flexibility Equations of Motion

$$M_i\ddot{q}_i = \xi_{i1}F_{s1} + \xi_{i2}F_{s2} + \xi_{i3}F_{s3} - 2\zeta_i\omega_i M_i\dot{q}_i - \omega_i^2 M_i q_i \text{ for the } i\underline{th} \text{ mode} \quad (11)$$

where:

M_i = the generalized mass

$\xi_{i1}, \xi_{i2}, \xi_{i3}$ = modal deflections at gear location 1, 2 and 3

ω_i = modal frequency

ζ_i = damping factor

$q_i, \dot{q}_i, \ddot{q}_i$ = generalized coordinate and time derivatives

The sign convention corresponding to Figure 1 and the equations of motion is as follows:

Z = Vertical Displacement	+ up
θ = Pitch	+ nose down
q = Deflection Due to Bending	+ up
X = Horizontal Translation	+ forward

Solution Algorithm:

The technique used for solving the coupled nonlinear differential equations of motion that describe the simulated aircraft is a three-term Taylor series. For example, the equation:

$$\ddot{X} = -c\dot{X} - kx \quad (12)$$

The three-term Taylor series representation can be written as:

$$x_{(I+1)} = x_I + \dot{x}_{(I)}(\Delta t) + \ddot{x}_{(I)}\frac{(\Delta t)^2}{2} \quad (13)$$

where: $I = 1 \rightarrow N$

The values for $\ddot{x}$, $\dot{x}$ and x from the previous step are substituted into

equation (13) and a new value for x is obtained. Differentiating equation (13) we obtain for the velocity $\dot{x}$, the expression

$$\dot{x}_{(I+1)} = \dot{x}_{(I)} + \ddot{x}_{(I)}(\Delta t) \tag{14}$$

The values for $\dot{x}$ and $\ddot{x}$ are then substituted into equation (14) and a new value of $\dot{x}$ is found. This entire process is repeated with the new values of x and $\dot{x}$ to obtain the next point in the solution.

In Section IV Table II identifies and shows the modifications of cards which are necessary for a Class E aircraft. All other data cards remain the same. Table III shows the format for inputing the runway profile data.

The sample problem at the end of this section simulates a Class C aircraft traversing the profile of Taxiway E at the Will Rogers International Airport at a constant speed of 100 feet per second. The sample problem output in order of occurrence is as follows:

TABLE IV	Runway Profile Listing
TABLE V	List of Input Data Used
TABLE VI	One Page of Listed Time History Output
Figure 6	Time History Plot

Class C Aircraft

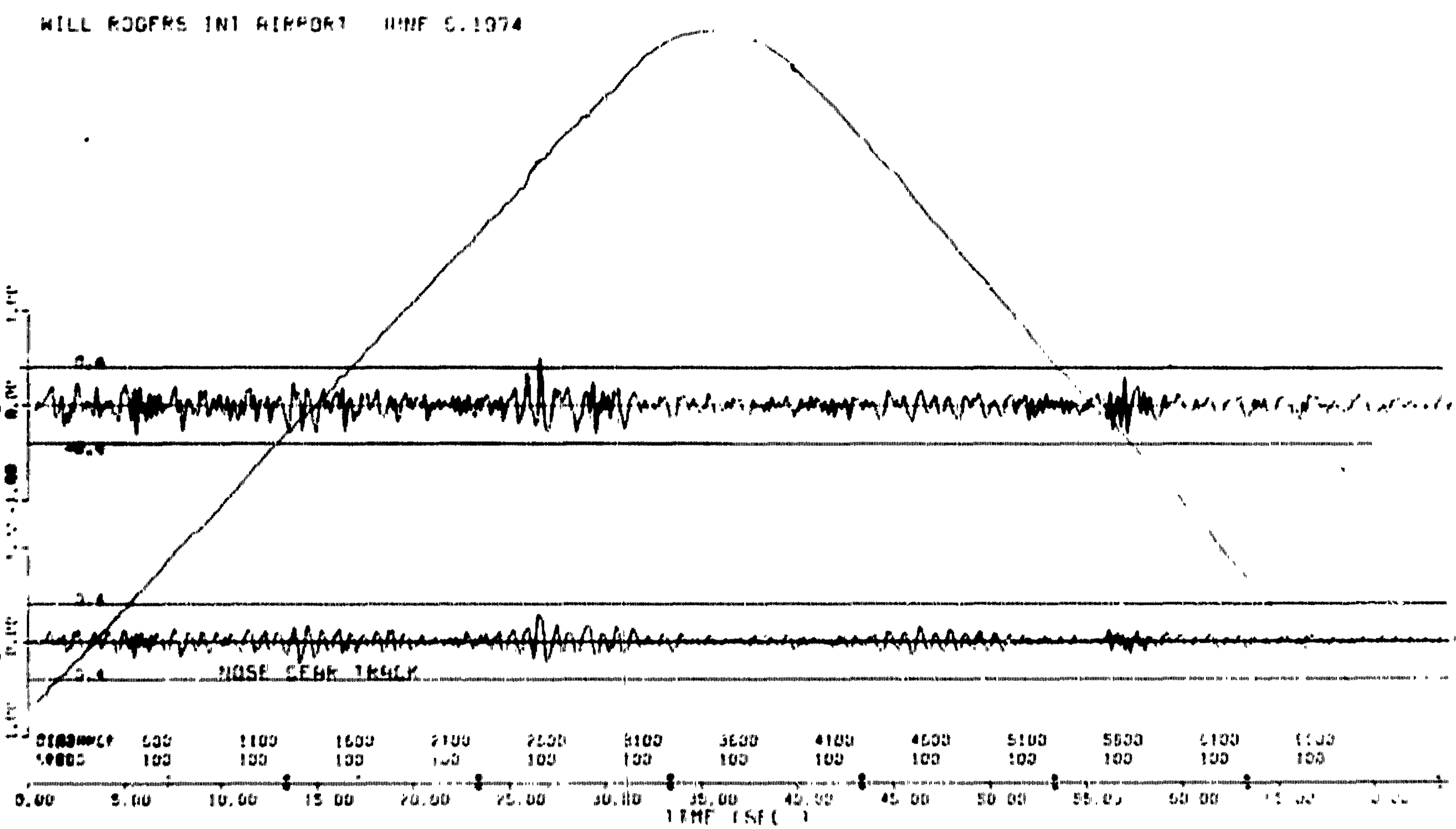


Figure 6 - Calcomp Plotted Results of Sample Problem

SECTION IV

COMPUTER PROGRAM

The computer program, used to predict the dynamic response of the commercial aircraft described in the next section, is the basic program described in Reference 1 with a few minor changes. These program changes include the capability to simulate strut bearing friction forces, multiple main landing gear struts, root mean square calculations, compressed plot capability, compressed or suppressed printing, and other minor improvements.

Appendix A contains a complete listing of the general computer program for all aircraft except the Class E aircraft. A complete listing for the program used to simulate the Class E aircraft is shown in Appendix B. To simulate a Class B aircraft with the inclusion of strut bearing friction, the separate "TAYLOR" subroutine listed in Appendix C, should be substituted for the "TAYLOR" subroutine included in the general program. If it is desired to run Class B aircraft without strut bearing friction, the general program can be used. Appendix D contains a complete listing of the FORTRAN symbols used.

The following tables I through V contain the form of the aircraft input data required for an aircraft airfield simulation. The data cards are sequenced as they must appear in the aircraft data deck. For each data card, variable names, definitions, units, card columns, and format field specifications are given.

Table I contains the form of the aircraft data deck for all conventional (Class A through D) landing gear aircraft. These aircraft all have main landing gear struts which are single acting and are non-articulated. Table I also contains the data used in the sample problem at the end of this section.

TABLE I

AIRCRAFT DATA FOR CONVENTIONAL AIRCRAFT

Section 1 (cards 1-5) - General Airplane Data

Card Column	Format	Variable Name	Data for Sample Problem	Definition
Card 1				
1-80	8A10	PLANE	Class C	Airplane Being Simulated
Card 2				
1-10	F10.1	W	306000.	Vehicle Weight (lb)
11-20	F10.1	A	30.	Distance Main Gear to CG (in)
~~21-30~~	F10.1	B	678.	Distance Nose Gear to CG (in)
31-42	F12.0	MMI	84700000.	Mass Moment of Inertia (lb in sec^2)
Card 3				
1-10	F10.2	PSARM	757	Distance of Pilot Station to CG (in)
11-20	F10.2	TAILRM	637	Distance of Tail Station to CG (in)
Card 4				
1-10	F10.2	SPEED	100	Initial Velocity of Airplane (ft/sec)
11-20	F10.2	THRUST	48000.	Total Airplane Thrust (lb)
21-30	F10.2	TAKEOFF	289.	Airplane Rotation Speed (ft/sec)
Card 5				
1-10	F10.4	CL	.603	Lift Coefficient
11-20	F10.4	AREA	2890.	Wing Area (ft^2)
21-30	F10.4	CD	.03	Drag Coefficient

Section 2 (cards 6-11) - Main and Nose Gear

Card Column	Format	Variable Name	Data for Sample Problem	Definition
Card 6				
1-10	F10.2	WM	1659.	Unsprung Weight of Each Main Gear (lb)
11-20	F10.2	WN	432.	Unsprung Weight of Nose Gear (lb)
21-30	F10.2	SXM	2.	Number of Main Gear Struts
31-40	F10.2	SXN	1.	Number of Nose Gear Struts

Card Column	Format	Variable Name	Data for Sample Problem	Definition
1-10	F10.5	AHN	13.91	Hydraulic Piston Area Nose (in^2)
11-20	F10.5	AAN	19.64	Pneumatic Piston Area Nose (in^2)
21-30	F10.5	AHM	66.80	Hydraulic Piston Area Main (in^2)
31-40	F10.5	AAM	78.47	Pneumatic Piston Area Main (in^2)

Card 8

1-10	F10.5	PAON	265.	Nose Strut Preload Pressure (lb/in^2)
11-20	F10.5	PAOM	243.	Main Strut Preload Pressure (lb/in^2)
21-30	F10.5	VON	335.	Fully Extended Nose Strut Air Volume (in^3)
31-40	F10.5	VOM	1816.6	Fully Extended Main Strut Air Volume (in^3)
41-50	F10.5	OAM	3.14	Orifice Area Main (in^2)
51-60	F10.5	OAN	1.23	Orifice Area Nose (in^2)

Card 9

1-10	F10.3	SLM	91.0	Distance from Axle to CG Waterline Main Gear Strut Unloaded (in)
11-20	F10.3	SLN	91.0	Distance from Axle to CG Waterline Nose Gear Strut Unloaded (in)

Card 10

1-10	F10.1	TSM	25050.	Main Tire Spring Constant Per Strut (lb/in)
11-20	F10.1	TSN	13000.	Nose Tire Spring Constant Per Strut (lb/in)

Card 11

1-10	F10.5	DX	.001	Integration Step Size

Card 12

1-5	I5	IFPLOT	0	0-Plot; 1-No Plot
6-10	I5	IFLIST	0	0-List; 1-No Plot

Section 3 (cards 13-16)-Metering Pin Description

Card 13

1-5	I5	NSCN	7	Number of Slope Changes Nose Gear

Card Column	Format	Variable Name	Data for Sample Problem	Definition
*Card 14A, 14B,....				
1-10	F10.3	STROKN (I)	*	Stroke Corresponding to Metering Pin Diameter, Nose Gear
11-20	F10.3	PINDN (I)	*	Metering Pin Diameter, Nose Gear (in)
Card 15				
1-5	I5	NSCM	9	Number of Slope Changes Main Gear
*Card 16A, 16B,....				
1-10	F10.3	STROKM (I)	*	Stroke Corresponding to Metering Pin Diameter, Nose Gear
11-20	F10.3	PINDM (I)	*	Metering Pin Diameter, Main Gear (in)
Section 4 (cards 17-19)-Flexibility Data				
Card 17				
1-5	I5	NFM	10	Number of Flexible Modes
**Card 18A, 18B.....				
1-10	F10.3	SIMAIN (I)	**	Mode Shape Deflection Main Gear
11-20	F10.3	SINOSE (I)	**	Mode Shape Deflection Nose Gear
21-30	F10.3	SICG (I)	**	Mode Shape Deflection CG
31-40	F10.3	SITAIL (I)	**	Mode Shape Deflection Tail Station
41-50	F10.3	SIPS (I)	**	Mode Shape Deflection Pilot Station
**Card 19A, 19B,....				
1-15	F15.2	GM (I)	**	Generalized Mass (lb sec^2/in)
16-25	F10.3	OMEGA (I)	**	Modal Frequency (rad/sec)

*One card is required for each stroke-metering pin combination read into the program.

Data for Sample Problem is shown in Table V.

**One card is required for each flexible mode. Data for Sample Problem is shown in Table V.

TABLE II

INPUT DATA CHANGES FOR CLASS E AIRCRAFT

Card Column	Format	Variable Name	Definition
Card 2			
1-10	F10.1	W	Vehicle Weight (lbs)
11-20	F10.1	A	Distance Front Main Gear to CG (in)
21-30	F10.1	B	Distance Nose Gear to CG (in)
31-40	F10.1	C	Distance Rear Main Gear to CG (in)
41-52	F12.0	MMI	Mass Moment of Inertia (lbin sec^2)
Card 6			
1-10	F10.2	WM	Unsprung Weight of Each Front Main Gear (lbs)
11-20	F10.2	WN	Unsprung Weight of Nose Gear (lbs)
21-30	F10.2	SXM	Number of Main Gear Struts
31-40	F10.2	SXN	Number of Nose Near Struts
41-50	F10.2	WRM	Unsprung Weight of Each Rear Main Gear (lbs)
Card 7			
1-10	F10.5	AHN	Hydraulic Piston Area Nose (in^2)
11-20	F10.5	AAN	Pneumatic Piston Area Nose (in^2)
21-30	F10.5	AHM	Hydraulic Piston Area Front Main (in^2)
31-40	F10.5	AAM	Pneumatic Piston Area Front Main (in^2)
41-50	F10.5	AHRM	Hydraulic Piston Area Rear Main (in^2)
51-60	F10.5	AARM	Pneumatic Piston Area Rear Main (in^2)
Card 8			
1-10	F10.5	PAON	Nose Strut Preload Pressure (lbs/in^2)
11-20	F10.5	PAOM	Front Main Strut Preload Pressure (lbs/in^2)
21-30	F10.5	VON	Fully Extended Nose Strut Air Volume (in^3)
31-40	F10.5	VOM	Fully Extended Front Main Strut Air Volume (in^3)
41-50	F10.5	OAM	Orifice Area Front Main (in^2)
51-60	F10.5	OAN	Orifice Area Nose (in^2)
61-70	F10.5	PAORM	Rear Main Strut Preload Pressure (lbs/in^2)
71-80	F10.5	VORM	Fully Extended Rear Main Strut Air Volume (in^3)
Card 10			
1-10	F10.1	TSM	Front Main Tire Spring Constant Per Strut (lbs/in)
11-20	F10.1	TSN	Nose Tire Spring Constant Per Strut (lbs/in)
21-30	F10.1	TSRM	Rear Main Tire Spring Constant Per Strut (lbs/in)
31-40	F10.1	OARM	Orifice Area Rear Main (in^2)

Runway Profile Magnetic Tape

The runway profile is read into the program from a magnetic tape or permanent file. The format for this tape is shown in Table III.

TABLE III

RUNWAY PROFILE MAGNETIC TAPE

Column	Format	Variable Name	Definition
Read 1			
1-80	8A10	SITE	Runway Profile and Direction
Read 2			
1-6	I6	NPTSS	Number of Runway Elevation Points
*Read 3, 4,....N+2			
1-70	10F7.3	ELEV	Runway Profile Data

*One read required for every ten runway profile elevation points.

Figure 7 contains a schematic diagram of the source deck setup for all aircraft simulations.

In order to simulate Class B aircraft with the strut friction force included, changes must be made to the basic program. This change is required as a result of the main and nose landing gear having a significant angle from the vertical and an axle offset on the main landing gear. The Class B aircraft source deck is formed by removing the subroutine Taylor from the basic source deck and replacing it with the Taylor shown in Appendix C.

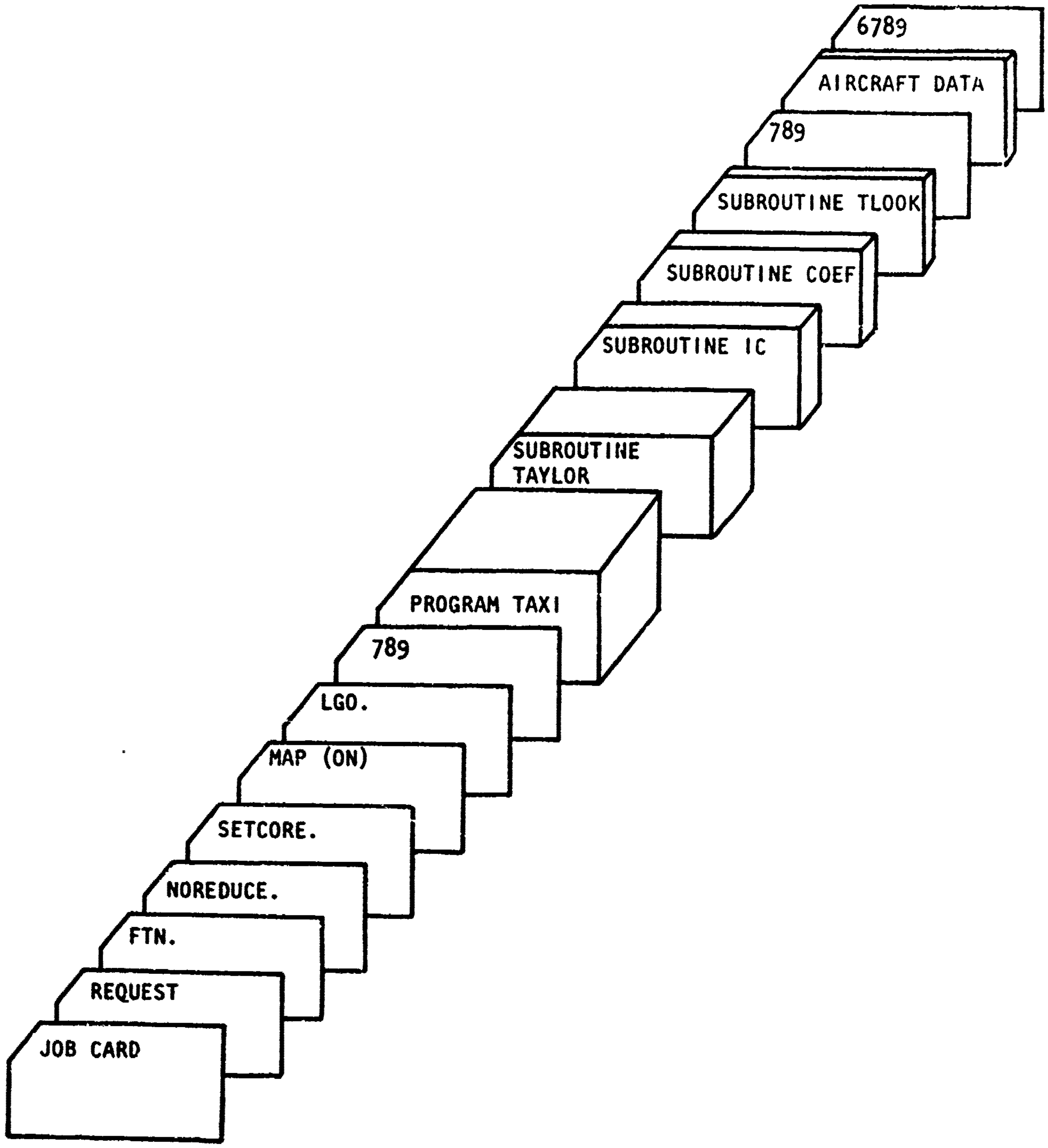


Figure 7 - Source Deck Setup for All Aircraft

TABLE IV - Profile Data of Will Rogers International Airport's Taxiway E used in the Sample Problem

RUNWAY PROFILE DATA NORMALIZED (SLOPE REMOVED)

WILL ROGERS INT AIRPORT JUNE 6,1974 TAXIWAY E

										FEET DOWN THE RUNWAY
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	20
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	40
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	60
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	80
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	100
0.00000	.17380	.32361	.41341	.65922	.74902	.89883	.97663	1.05444	1.24024	120
1.41405	1.46785	1.47366	1.49146	1.46127	1.43107	1.48488	1.51468	1.56849	1.61029	140
1.64010	1.64590	1.79571	1.84951	1.90332	1.90912	2.02293	2.22073	2.43054	2.58034	160
2.70615	2.87995	3.14976	3.28756	3.38937	3.46717	3.50898	3.52678	3.52059	3.58639	180
3.67620	3.76600	3.90381	4.01761	4.05942	4.04122	4.09503	4.08883	4.14264	4.19644	200
4.31025	4.37605	4.51386	4.61566	4.71747	4.75927	4.81308	4.93888	5.08859	5.17849	220
5.26830	5.32210	5.30391	5.29771	5.35152	5.36932	5.45913	5.59493	5.68674	5.78854	240
5.92635	5.96815	6.08196	6.18376	6.18957	6.26737	6.33318	6.37498	6.44079	6.54259	260
6.63240	6.79420	6.89601	6.94981	7.12362	7.29742	7.38723	7.45303	7.56684	7.66864	280
7.74645	7.87225	7.92606	7.91986	7.99767	8.09947	8.22528	8.30308	8.39289	8.54269	300
8.65650	8.77030	8.86011	8.92591	8.97972	9.02152	9.17133	9.24913	9.25494	9.28474	320
9.26655	9.30835	9.37416	9.36796	9.43377	9.47557	9.56538	9.53318	9.72099	9.85879	340
10.00860	10.18240	10.36820	10.53001	10.67981	10.69762	10.89542	10.98523	11.13503	11.22484	360
11.27864	11.33245	11.42225	11.45206	11.55386	11.66767	11.69747	11.73728	11.93708	11.95489	380
12.04469	12.07450	12.14030	12.20611	12.29591	12.39772	12.48752	12.57733	12.75113	12.79294	400
12.85874	12.94855	12.97835	13.06816	13.14596	13.28377	13.43357	13.53538	13.60118	13.65499	420
13.78079	13.78660	13.85240	13.90621	14.05601	14.18182	14.30762	14.44543	14.52323	14.68504	440
14.76284	14.81665	14.89445	15.00826	15.07406	15.16387	15.24167	15.33148	15.33728	15.42709	460
15.43289	15.49870	15.54050	15.58231	15.63611	15.76192	15.82772	15.94153	16.05533	16.13314	480
16.27094	16.38475	16.52255	16.66036	16.83416	16.97197	17.08577	17.18758	17.31338	17.34319	500
17.39699	17.51080	17.63660	17.71441	17.87621	17.95402	18.05582	18.16963	18.25943	18.26524	520
18.40304	18.38485	18.42665	18.50446	18.57026	18.62407	18.83387	18.93568	19.42148	19.57129	540
19.76939	19.79890	19.87670	19.93051	19.76831	19.70212	19.67192	19.65373	19.74353	19.88134	560
20.06714	20.06895	20.21075	20.36856	20.46236	20.67217	20.71397	20.76778	20.88158	21.00739	580
21.04919	21.09100	21.15680	21.17460	21.30041	21.37821	21.52802	21.64182	21.77963	21.84543	600
21.94724	22.08504	22.16285	22.26465	22.36646	22.48026	22.65407	22.73187	22.80968	23.00748	620
23.19329	23.37909	23.43290	23.47470	23.55251	23.61831	23.70812	23.89392	23.98373	24.00153	640
24.01934	23.98914	23.94695	24.00075	24.01856	24.02436	23.99417	24.10797	24.13778	24.23958	660
24.36539	24.40719	24.53300	24.59880	24.65261	24.79041	24.92822	25.05402	25.17983	25.29363	680
25.35944	25.46124	25.52705	25.56885	25.74266	25.83246	25.93427	26.02407	26.17388	26.31168	700
26.42549	26.55129	26.60510	26.67090	26.77271	26.82651	26.89232	26.99412	27.03593	27.08973	720
27.08354	27.19734	27.26315	27.30495	27.46676	27.54456	27.62237	27.74817	27.82598	27.86778	740
27.99359	28.03539	28.08920	28.21500	28.36481	28.44261	28.66442	28.82622	28.94003	29.01783	760
29.05964	29.17344	29.23925	29.40105	29.45486	29.50866	29.69447	29.82027	30.00608	30.17988	780
30.32969	30.40749	30.49730	30.62310	30.62891	30.58671	30.64052	30.73032	30.74813	30.86193	800
30.93974	31.02954	31.14335	31.25715	31.39496	31.49676	31.56257	31.73637	31.83818	31.90398	820
31.99379	32.25159	32.31740	32.41920	32.53300	32.51481	32.59261	32.71842	32.76022	32.86203	840
32.91583	32.95764	32.98744	33.11325	33.21505	33.24486	33.31066	33.28047	33.39427	33.58008	860
33.63388	33.72369	33.77749	33.86730	33.94510	33.99891	34.07671	34.15452	34.31632	34.44213	880
34.59193	34.69374	34.79554	34.92135	34.97515	34.39296	35.09476	35.26857	35.41837	35.53218	900
35.64598	35.73579	35.90959	35.90340	35.96920	36.08301	36.08881	36.20262	36.20842	36.22623	920
36.20803	36.18984	36.18364	36.18945	36.25525	36.29706	36.39886	36.41667	36.45847	36.47628	940
36.48208	36.57189	36.70969	36.91950	37.03330	37.20711	37.23691	37.23072	37.28452	37.31433	960

TABLE IV - Continued

37.38013	37.54194	37.61974	37.70955	37.76735	37.86516	38.03696	38.11677	38.17057	38.38038	980
38.32618	38.54799	38.55379	38.70360	38.75740	38.94321	38.92501	39.00282	39.08062	39.11043	1000
39.20023	39.27804	39.37984	39.37365	39.47545	39.55326	39.64306	39.58887	39.76257	39.80448	1020
39.91828	40.27209	40.32589	40.39170	40.48150	40.47531	40.60111	40.61892	40.62472	40.66653	1040
40.75633	40.78614	40.92394	40.97775	41.09155	41.18136	41.28316	41.38497	41.51077	41.66058	1060
41.85838	42.05619	42.22999	42.33180	42.37360	42.42740	42.54121	42.60701	42.66052	42.71462	1080
42.78043	42.90623	43.09204	43.24184	43.37965	43.45745	43.53526	43.60106	43.73887	43.84067	1100
43.88248	43.88828	43.91809	43.94789	44.04970	44.11550	44.16931	44.25911	44.36092	44.53472	1120
44.56453	44.66633	44.68414	44.73794	44.71975	44.84155	44.99536	45.07316	45.12097	45.22877	1140
45.38658	45.50438	45.65419	45.68399	45.78580	45.85160	45.95341	46.01921	46.15702	46.30582	1160
46.54063	46.72643	46.72824	46.88204	46.83935	46.80965	46.91146	46.93926	47.09107	47.26487	1180
47.34268	47.51648	47.58229	47.63609	47.73790	47.75570	47.91751	47.93531	48.01312	48.69092	1200
48.12073	48.34253	48.44434	48.56214	48.61195	48.64175	48.77956	48.93336	48.98317	49.06097	1220
49.13878	49.30058	49.42639	49.50419	49.63000	49.86380	50.00161	50.03141	50.19322	50.22302	1240
50.25283	50.30663	50.33644	50.42624	50.50405	50.58185	50.67166	50.72546	50.81527	50.89307	1260
50.98288	51.07268	51.19849	51.32429	51.46210	51.55190	51.60571	51.69551	51.78532	51.87312	1280
51.92893	52.06673	52.22854	52.33034	52.34815	52.44995	52.59976	52.67756	52.81537	52.90517	1300
52.97098	53.03678	53.15059	53.27639	53.33020	53.40800	53.55780	53.65961	53.72541	53.83922	1320
53.91702	54.04283	54.08463	54.13844	54.24024	54.30605	54.44385	54.53366	54.61146	54.72527	1340
54.71907	54.77288	54.76068	54.72449	54.77829	54.88010	54.93390	55.07171	55.18551	55.29932	1360
55.46112	55.57493	55.61673	55.66254	55.77234	55.83815	55.92795	55.98176	56.05956	56.18537	1380
56.32317	56.42498	56.57478	56.68859	56.80239	56.90420	57.00600	57.05981	57.18561	57.32342	1400
57.41322	57.43103	57.54483	57.59864	57.70044	57.19025	57.18405	57.18986	57.27956	57.38147	1420
57.45527	57.62108	57.80688	57.94469	58.04649	58.18430	58.29810	58.35391	58.51371	58.68752	1440
58.80132	58.89113	58.95693	58.98674	59.06454	59.17835	59.36415	59.51396	59.51976	59.53757	1460
59.50737	59.58518	59.71098	59.86079	59.87859	59.89240	60.11820	60.23201	60.30981	60.24362	1480
60.29742	60.35123	60.35703	60.50684	60.56064	60.61445	60.70425	60.81806	60.95986	61.09367	1500
61.08747	61.12928	61.14708	61.18889	61.27869	61.42850	61.54230	61.69211	61.84191	61.95572	1520
61.98552	62.07533	62.11713	62.15894	62.20074	62.18255	62.27235	62.35016	62.37996	62.42177	1540
62.48757	62.54138	62.64318	62.75699	62.81079	62.90060	62.90640	62.95020	63.06201	63.21181	1560
63.33762	63.41542	63.46923	63.49903	63.60084	63.65464	63.82845	63.84625	63.98406	64.07386	1580
64.16367	64.25347	64.29528	64.38508	64.53489	64.67269	64.64250	64.74430	64.85811	64.89991	1600
64.97772	65.00752	65.02933	65.05513	65.07294	65.29474	65.51655	65.70235	65.82816	66.01396	1620
66.27177	66.43357	66.36738	66.37318	66.34299	66.40879	66.39060	66.48040	66.53471	66.58801	1640
66.65382	66.73162	66.89343	67.01923	67.21704	67.36684	67.48065	67.63045	67.80466	67.95406	1660
68.16387	68.28967	68.45148	68.61328	68.69109	68.76089	68.88270	68.99650	69.06231	69.11611	1680
69.09792	69.11572	69.14553	69.23533	69.27714	69.30694	69.27675	69.27055	69.25236	69.30616	1700
69.28797	69.31777	69.43150	69.60538	69.68319	69.84499	69.89880	70.01260	70.11441	[illegible]	1720
70.31802	70.44382	70.59363	70.74343	70.86924	70.93504	71.01285	71.05465	71.07745	71.14826	1740
71.31207	71.35387	71.35968	71.41348	71.56329	71.64109	71.74290	71.90470	71.95851	71.97231	1760
71.99412	71.99992	72.02973	72.08353	72.29334	72.35914	72.40095	72.41875	72.55656	72.61036	1780
72.74817	72.75397	72.86778	73.02958	73.08339	73.17319	73.25100	73.30480	73.52860	73.65241	1800
73.80221	74.02402	74.18582	74.27563	74.44943	74.58724	74.66504	74.74285	74.79065	74.86246	1820
74.96426	75.11407	75.16787	75.16168	75.17948	75.20929	75.28709	75.30490	75.40670	75.54451	1840
75.67031	75.66412	75.64592	75.71173	75.76553	75.87934	76.04114	76.15495	76.22075	76.25055	1860
76.28036	76.39417	76.57997	76.72978	77.05958	77.13739	77.25119	77.35300	77.37000	77.38861	1880
77.45441	77.58022	77.64602	77.77183	77.87363	78.02344	78.22124	78.32305	78.38085	78.40666	1900
78.53246	78.52627	78.55607	78.59788	78.67568	78.66949	78.78329	78.78910	78.86690	78.86071	1920
78.93851	79.07632	79.26212	79.41193	79.50173	79.61554	79.68134	79.74715	79.78495	79.87876	1940
79.96856	80.01837	80.02817	80.15398	80.24378	80.36959	80.47139	80.56120	80.57900	80.64481	1960

TABLE IV - Continued

80.66261	80.80042	80.90222	80.96803	81.00983	81.06364	81.14144	81.31525	81.41705	81.63886	1980
81.72866	81.74647	81.83627	82.02208	82.12388	82.27369	82.37549	82.41730	82.45910	82.63291	2000
82.68671	82.74052	82.89032	83.01613	83.12993	83.23174	83.29754	83.37535	83.45315	83.48296	2020
83.58476	83.71057	83.81237	83.83018	83.82398	83.87779	83.84759	83.90140	83.95520	84.00900	2040
84.11081	84.27261	84.33842	84.51222	84.71003	84.75183	84.85364	84.89544	84.90125	84.97905	2060
85.04486	85.09866	85.16447	85.20627	85.23608	85.39788	85.43969	85.56549	85.65530	85.73310	2080
85.84691	86.00871	86.09852	86.15232	86.37413	86.51193	86.60174	86.66754	86.70935	86.73915	2100
86.78096	86.83476	86.94857	87.06237	87.17618	87.25398	87.31979	87.42159	87.48740	87.57720	2120
87.65501	87.76881	87.85862	87.93642	87.94223	88.02003	88.06184	88.11564	88.21745	88.30725	2140
88.38506	88.52286	88.56467	88.67847	88.76828	88.89408	88.94789	89.02569	89.06750	89.19330	2160
89.34311	89.38491	89.52272	89.62452	89.75033	89.86413	90.00194	90.09174	90.18155	90.19935	2180
90.26516	90.33096	90.39677	90.52257	90.66038	90.75018	90.79199	90.91779	91.01960	91.18140	2200
91.31921	91.43301	91.47482	91.52862	91.69043	91.69623	91.81004	91.87584	92.03765	92.16345	2220
92.25326	92.35506	92.44487	92.53467	92.70848	92.81028	92.81609	92.84589	92.88770	92.95350	2240
92.99531	93.10911	93.19892	93.27672	93.29453	93.37233	93.51014	93.56394	93.62975	93.70755	2260
93.76136	93.80316	93.96497	94.03077	94.02458	94.05438	94.13219	94.46199	94.50380	94.65360	2280
94.74340	94.74921	94.85101	94.96482	95.06662	95.12043	95.16223	95.31204	95.41384	95.44365	2300
95.46145	95.55126	95.65306	95.65887	95.70067	95.74248	95.80828	95.86209	95.92789	95.99370	2320
96.19150	96.31731	96.41911	96.44892	96.47872	96.53253	96.64533	96.76014	96.78994	96.92775	2340
96.95755	97.03536	97.05316	97.11897	97.22077	97.23858	97.23038	97.33419	97.43599	97.54980	2360
97.57960	97.68141	97.74721	97.83702	97.84282	97.94463	[illegible]	98.32824	98.58204	98.62785	2380
98.71765	98.73546	98.95726	98.97507	99.10087	99.14268	99.29240	99.38229	99.46009	99.42990	2400
99.49570	99.62151	99.65131	99.77712	99.78292	99.88473	100.08253	100.24434	100.45414	100.55595	2420
100.74175	100.79556	100.92136	100.99917	101.06497	101.23878	101.36458	101.45439	101.59219	101.75400	2440
101.80780	101.96961	102.09541	102.34122	102.56302	102.61683	102.59863	102.56844	[illegible]	102.60405	2460
102.59785	102.53166	102.63346	102.69927	102.71707	102.77088	102.84868	102.97449	103.04029	103.15410	2480
103.18390	103.27371	103.38751	103.44132	103.50712	103.57293	103.61473	103.72854	103.83034	103.83615	2500
103.94995	103.99176	104.08156	104.19537	104.30917	104.38698	104.47678	104.63859	104.74039	104.85420	2520
104.99200	105.89380	105.30361	105.41741	105.48322	105.62102	105.71083	105.80063	105.86644	105.90824	2540
106.01005	106.03985	106.10566	106.20746	106.32127	106.42307	106.42888	106.44668	106.52449	106.60229	2560
106.62010	106.69790	106.72771	106.73351	106.78732	106.80512	107.01493	107.21273	107.30254	107.35634	2580
107.39815	107.43995	107.50576	107.64356	107.72137	107.91917	108.04498	108.20678	108.28459	108.38639	2600
108.50020	108.56600	108.59581	108.55361	108.81142	108.98522	109.05103	109.15283	109.18264	109.28444	2620
109.25425	109.16405	109.07386	109.05566	109.04947	109.05727	109.13308	109.16288	109.21669	109.28249	2640
109.42030	109.55810	109.73191	109.92971	109.99552	110.88932	111.06313	111.36893	111.65074	111.96854	2660
112.27435	112.42415	112.53796	112.61576	112.74157	112.90337	113.12518	113.37098	113.48479	113.50259	2680
113.61640	113.69420	113.78401	113.83781	113.92762	114.10142	114.19123	114.28103	114.39484	114.46064	2700
114.47845	114.64025	114.73006	114.79586	114.87367	114.39947	115.13728	115.19108	115.32489	115.40669	2720
115.40050	115.45430	115.54411	115.52591	115.51972	115.58552	115.65133	115.73513	115.73494	115.77674	2740
115.75855	115.80035	115.85416	115.97996	116.03377	116.07557	116.21338	116.25518	116.33299	116.39879	2760
116.46460	116.44640	116.59620	116.68601	116.75181	116.96162	117.05142	117.15323	117.25503	117.41684	2780
117.47064	117.53645	117.69825	117.83606	117.99786	118.06367	118.22547	118.38728	118.52508	118.66289	2800
118.82469	118.86650	119.04030	119.10611	119.24391	119.33372	119.39952	119.48933	119.57913	119.65694	2820
119.68674	119.75255	119.83035	119.90816	120.04596	120.13577	120.22557	120.26738	120.39318	120.43499	2840
120.47679	120.49460	120.52440	120.61421	120.63201	120.75782	120.82362	120.94943	121.06323	121.15304	2860
121.23084	121.32065	121.39845	121.44026	121.53006	121.52387	121.60167	121.65748	121.80528	121.84709	2880
121.97289	122.08670	122.14050	122.18231	122.20611	122.31592	122.35572	122.40953	122.46333	122.50514	2900
122.59494	122.67275	122.78655	122.62836	122.63416	122.87597	122.69377	122.89958	122.91733	122.91119	2920
123.30099	123.55880	123.74460	123.90641	124.18321	124.23002	124.42782	124.54163	124.63143	124.74524	2940
124.61904	124.61205	124.57085	124.55246	124.55826	124.54007	124.59387	124.61168	124.66540	124.69529	2960

TABLE IV - Continued

124.70109	124.69490	124.73670	124.80251	124.80831	124.88612	124.99992	125.14973	125.27553	125.36534	2980
125.47914	125.61695	125.71875	125.84456	125.91036	126.04817	126.17397	126.26378	126.28158	126.39539	3000
126.52119	126.63500	126.64080	126.74260	126.84441	126.98221	127.07202	127.18582	127.23963	127.28143	3020
127.31124	127.35304	127.50285	127.61665	127.65846	127.74826	127.79007	127.90387	127.99368	128.07148	3040
128.16129	128.26309	128.34090	128.40670	128.47251	128.59831	128.67512	128.83792	128.85573	128.90953	3060
129.03534	129.12514	129.20295	129.23275	129.27456	129.30436	129.45417	129.42397	129.63378	129.67558	3080
129.64539	129.62719	129.72900	129.73480	129.68061	129.72241	129.82422	129.84202	129.90783	129.97363	3100
130.02744	130.12924	130.17105	130.23685	130.32666	130.41646	130.45827	130.54407	130.61788	130.97968	3120
131.10549	131.25529	131.40510	131.49430	131.41671	131.55451	131.71632	131.80612	131.84793	131.96173	3140
132.01554	132.15334	132.31515	132.35695	132.47076	132.50056	132.63837	132.71617	132.93798	133.05778	3160
133.16559	133.30339	133.30920	133.45900	133.59681	133.68661	133.71642	133.85422	133.94403	134.03363	3180
134.07564	134.17744	134.24325	134.27305	134.35086	134.47666	134.60247	134.66827	134.69808	134.87188	3200
134.92569	135.00349	135.00930	135.11110	135.20091	135.24271	135.28452	135.32632	135.41613	135.44593	3220
135.42774	135.60154	135.71535	135.74515	135.84696	135.92476	136.02657	136.15237	136.20618	136.31498	3240
136.44579	136.59559	136.68540	136.78720	136.93700	137.12281	137.14061	137.25442	137.34422	137.38603	3260
137.52383	137.61364	137.64344	137.73325	137.87105	137.93686	137.87066	137.96047	138.05027	138.11[illegible]	3280
138.14588	138.21169	138.20549	138.16330	138.28910	138.34291	138.38471	138.48552	138.55232	138.55[illegible]	3300
138.57593	138.61774	138.71954	138.76135	138.87515	138.97096	138.99476	139.06057	139.12637	139.19218	3320
139.25798	139.28779	139.38959	139.39540	139.49720	139.50301	139.56881	139.58662	139.72442	139.73023	3340
139.78403	139.82584	139.85564	139.94545	139.96325	140.08906	140.10686	140.13667	140.25047	140.28028	3360
140.26208	140.33989	140.42969	140.41150	140.57330	140.62711	140.64491	140.63672	140.74052	140.81833	3380
140.84813	140.87794	140.93174	140.96155	140.99135	141.09316	141.07496	141.15277	141.14657	141.22438	3400
141.30218	141.34399	141.33779	141.33160	141.44540	141.46321	141.48101	141.60682	141.61262	141.64243	3420
141.69623	141.71404	141.70784	141.73765	141.79145	141.79726	141.80305	141.83287	141.83867	141.84448	3440
141.92228	141.89209	141.96989	142.01170	142.02950	142.09531	142.13711	142.16692	142.22072	142.22653	3460
142.24433	142.28614	142.27994	142.30975	142.42355	142.36936	142.42316	142.42897	142.35077	142.36858	3480
142.42238	142.39219	142.43399	: 2.41580	142.43360	142.45140	142.52921	142.51101	142.48082	142.54662	3500
142.62443	142.61823	142.68404	142.67784	142.66365	142.66545	142.64726	142.64106	142.73087	142.71267	3520
142.74248	142.74828	142.79009	142.81989	142.86170	142.87950	142.92131	142.89111	142.88492	142.66672	3540
142.92053	142.91433	142.92014	142.94994	142.90775	142.91355	142.94336	142.93516	142.96697	142.97277	3560
142.97858	142.96038	142.94219	142.87599	142.92980	142.97160	143.01341	142.97121	143.04902	143.06682	3580
143.08463	143.05443	143.06024	143.09004	143.03585	143.14965	143.10746	143.11326	143.15507	143.11287	3600
143.13068	143.11248	143.15429	143.13609	143.11790	143.09970	143.21351	143.15931	143.18912	143.18292	3620
143.12873	143.11053	143.20034	143.20614	143.21195	143.18175	143.17556	143.15736	143.16317	143.15697	3640
143.15078	143.02458	143.12639	143.10819	143.09000	143.10780	143.01761	142.99941	143.06522	143.14302	3660
143.11283	143.08263	143.04044	143.04624	143.04005	143.02185	142.95566	142.96146	142.94327	142.94907	3680
142.90688	142.91268	142.89449	142.86429	142.84610	142.88790	142.88171	142.89951	142.79732	142.82712	3700
142.85693	142.87473	142.78454	142.70634	142.74815	142.71795	142.68776	142.69356	142.74737	142.71717	3720
142.69898	142.69278	142.66259	142.64439	142.60220	142.57200	142.52980	142.57161	142.51741	142.48722	3740
142.46902	142.42683	142.40863	142.36644	142.33624	142.28205	142.21585	142.18566	142.23946	[illegible]	3760
142.28707	142.29288	142.28668	142.23249	142.21429	142.20810	142.16590	142.15971	142.11751	142.06332	3780
142.05712	142.11093	142.02073	141.96654	142.09234	142.08615	141.98395	141.92976	141.85155	141.84537	3800
141.79117	141.83298	141.79078	141.77259	141.75439	141.76020	141.67000	141.62781	141.63351	141.57942	3820
141.50122	141.44703	141.39283	141.36264	141.33244	141.29025	141.23605	141.19386	141.13966	141.02547	3840
141.01927	140.90508	140.82688	140.84469	140.76649	140.65230	140.62210	140.67591	140.63371	140.57952	3860
140.56132	140.56713	140.52493	140.55474	140.51254	140.45835	140.40415	140.37396	140.36776	140.36157	3880
140.33137	140.27718	140.22298	140.20479	140.16259	140.09640	140.06620	140.01201	140.01781	139.99962	3900
139.99342	139.93923	139.82503	139.68684	139.62064	139.53045	139.53625	139.44606	139.34386	139.30167	3920
139.19947	139.10928	139.07908	138.98889	138.89369	138.84450	138.80230	138.72411	138.68191	138.65172	3940
138.59752	138.55533	138.48913	138.43494	138.40474	138.31455	138.22435	138.18216	138.17536	138.10977	3960

TABLE IV - Continued

138.01957	138.03738	137.94718	137.94099	137.88679	137.86860	137.80240	137.73620	137.64601	137.55581	3980
137.50162	137.48342	137.42923	137.39903	137.39284	137.35064	137.28445	137.21825	137.15206	137.06186	4000
137.00767	136.96547	136.83928	136.82108	136.69489	136.61669	136.59850	136.50830	136.46611	136.37591	4020
136.33372	136.17152	136.02133	135.94313	135.88894	135.78674	135.72055	135.57035	135.49216	135.37796	4040
135.31177	135.13757	135.08338	134.90918	134.83099	134.69279	134.62660	134.51240	134.49421	134.41601	4060
134.38582	134.29562	134.27743	134.18723	134.14504	134.12684	134.03665	134.04245	133.88026	133.79006	4080
133.74787	133.57367	133.51948	133.42928	133.32709	133.21289	133.13470	132.98450	132.97831	132.91211	4100
132.80992	132.64772	132.52153	132.49133	132.50914	132.43094	132.29275	132.25055	132.18436	132.09416	4120
132.00397	131.88977	131.88358	131.72138	131.66719	131.58899	131.49880	131.45660	131.40241	131.27621	4140
131.23402	131.22782	131.07763	130.99943	130.92124	130.86704	130.70485	130.71065	130.58446	130.57826	4160
130.47637	130.31387	130.22368	130.15748	130.15129	130.06109	130.04290	130.01270	129.94651	130.00031	4180
129.91012	129.72392	129.57373	129.43553	129.35734	129.23114	129.14095	129.06275	128.98456	128.94236	4200
128.84017	128.76197	128.65978	128.53358	128.51539	128.44919	128.34700	128.28080	128.23450	128.18441	4220
128.17821	128.06402	127.93782	127.89[illegible]33	127.69743	127.64324	127.60104	127.52285	127.46865	127.31846	4240
127.32426	127.22207	127.16787	127.07768	127.02348	127.06529	126.93909	126.87290	126.84270	126.75251	4260
126.61431	126.52412	126.40992	126.27173	126.09753	125.98334	125.84514	125.73095	125.71275	125.62256	4280
125.48436	125.38217	125.29197	125.20178	125.18358	125.09339	124.95519	124.87700	124.81080	124.72061	4300
124.66641	124.58822	124.48602	124.40783	124.31763	124.25144	124.13724	124.05905	123.92085	123.85466	4320
123.76446	123.63827	123.52407	123.44588	123.34368	123.21749	123.06729	122.96510	122.81490	122.72471	4340
122.61851	122.48432	122.40612	122.27993	122.21373	122.17154	122.03334	121.89315	121.79295	121.66676	4360
121.58856	121.47437	121.39617	121.31798	121.17978	121.07759	120.98739	120.84920	120.78300	120.69281	4380
120.59061	120.48842	120.43422	120.38003	120.27783	120.22364	120.16944	120.03125	120.07305	120.06686	4400
119.97666	119.89847	119.84427	119.85008	119.95188	119.80569	119.87949	119.66930	119.57910	119.50091	4420
119.39871	119.30852	119.19432	119.11613	119.01393	118.87574	118.83354	118.59935	118.47315	118.32296	4440
118.25676	118.23857	118.13637	117.98618	117.84798	117.61379	117.35559	117.18140	116.98320	116.83300	4460
116.77881	116.64661	116.58642	116.58022	116.50203	116.38783	116.33364	116.24344	116.17725	116.09905	4480
116.00686	115.93066	115.82847	115.70227	115.62408	115.50988	115.41969	115.34149	115.27530	115.16110	4500
115.10691	115.02871	114.97452	114.90832	114.80613	114.78793	114.66174	114.53554	114.55335	114.46315	4520
114.32896	114.30876	114.24057	114.11437	113.98818	113.98198	113.93979	113.87359	113.72340	113.60920	4540
113.45901	113.39281	113.33862	113.20042	113.19423	113.12803	113.03784	113.06764	112.98945	112.93525	4560
112.89306	112.79886	112.76067	112.80247	112.73628	112.62208	112.56789	112.42969	112.37550	112.33330	4580
112.20711	112.14891	112.06272	111.93652	111.84633	111.74413	111.61794	111.45774	111.32955	111.17935	4600
111.06516	110.87896	110.77677	110.66257	110.46438	110.41018	110.25999	110.16979	110.09160	109.94140	4620
109.82721	109.70101	109.56282	109.46062	109.33443	109.20823	109.05604	108.90784	108.79355	108.76345	4640
108.63726	108.54786	108.43287	108.33067	108.18048	108.04228	107.98489	107.81389	107.74770	107.64550	4660
107.57931	107.47711	107.41092	107.30872	107.18253	107.08033	107.00214	106.91194	106.77375	106.71955	4680
106.66536	106.47916	106.36497	106.28677	106.22058	106.15436	106.01619	105.93199	105.78780	105.67360	4700
105.55940	105.44521	105.39101	105.30082	105.22262	105.08443	105.03023	104.92034	104.86154	104.71165	4720
104.56145	104.49526	104.42906	104.36287	104.26067	104.11048	104.00828	103.87009	103.77989	103.67770	4740
103.56350	103.41331	103.29911	103.25692	103.05072	102.98053	102.87833	102.75214	102.63794	102.58375	4760
102.58555	102.30736	102.24116	102.19897	102.09677	102.07858	101.96438	101.79019	101.74739	101.69380	4780
101.57960	101.47741	101.47121	101.39302	101.33082	101.20463	101.19443	101.21224	101.03804	100.85185	4800
100.78565	100.80346	100.76126	100.69507	100.50887	100.40668	100.30448	100.25029	100.20809	100.04590	4820
99.97970	99.87751	99.79931	99.72112	99.60692	99.51673	99.48253	99.27634	99.13814	99.04795	4840
98.93375	98.88756	98.68136	98.57917	98.50097	98.38678	98.24858	98.18239	98.12819	98.07400	4860
98.03180	97.96561	97.83941	97.78522	97.71902	97.62883	97.44263	97.37644	97.21424	97.05205	4880
96.96185	96.94366	96.84146	96.73927	96.64907	96.45088	96.34868	96.18649	96.09629	95.98210	4900
95.85590	95.76571	95.73551	95.64532	95.54312	95.53693	95.39873	95.28454	95.12234	95.05615	4920
94.92995	94.86376	94.84556	94.63537	94.56917	94.44298	94.34078	94.20259	94.07639	94.03420	4940
93.94400	93.84180	93.69161	93.62541	93.52322	93.52902	93.48683	93.39663	93.29444	93.16824	4960

TABLE IV - Continued

93.09005	92.93985	92.84966	92.72346	92.57327	92.44707	92.41688	92.31468	92.20049	92.09829	4980
91.97210	91.91790	91.77971	91.68951	91.56332	91.53312	91.45493	91.35273	91.25054	91.18434	5000
91.15415	91.12395	91.04576	90.94356	90.78137	90.70317	90.62498	90.52278	90.42059	90.34239	5020
90.31220	90.23400	90.11981	90.05361	89.96342	89.86122	89.81903	89.74083	89.72204	89.57244	5040
89.45825	89.33205	89.30186	89.12766	88.98947	88.88727	88.79708	88.59888	88.48459	88.38249	5060
88.30430	88.31010	88.14791	87.98571	87.78752	87.68532	87.60713	87.52893	87.45074	87.34854	5080
87.24635	87.18015	87.05396	86.93976	86.78957	86.62737	86.54918	86.45898	86.35679	86.25659	5100
86.16440	86.07420	85.97201	85.89381	85.75562	85.70142	85.57523	85.50303	85.47834	85.42464	5120
85.38245	85.32825	85.15406	85.07586	84.98567	84.85947	84.70928	84.65108	84.51689	84.46269	5140
84.39650	84.30630	84.19211	84.14991	84.01172	83.93352	83.86733	83.83713	83.74694	83.66874	5160
83.50655	83.35635	83.24216	83.12796	83.04977	82.98357	82.88138	82.77918	82.72499	82.59679	5180
82.54460	82.47840	82.36420	82.27401	82.13581	81.99762	81.88342	81.69723	81.47503	81.26484	5200
81.17464	81.08445	81.07825	81.02406	81.05386	80.99967	81.01747	80.98728	80.93338	80.86689	5220
80.78869	80.67450	80.58430	80.49411	80.40391	80.26572	80.11552	80.07333	79.95913	79.90494	5240
79.73074	79.64055	79.53835	79.41216	79.35796	79.25777	79.12957	79.02738	78.94918	78.81099	5260
78.72079	78.63060	78.55240	78.41421	78.31201	78.17382	78.05962	77.83743	77.71123	77.57304	5280
77.43484	77.29665	77.24245	77.14026	77.09806	76.98387	76.90567	76.82748	76.72528	76.65909	5300
76.53289	76.47870	76.36450	76.28631	76.14811	76.04592	75.95572	75.88953	75.79933	75.67314	5320
75.64294	75.58875	75.43855	75.32436	75.27016	75.11997	75.01777	74.87958	74.80138	74.74719	5340
74.72899	74.57880	74.50060	74.33841	74.29621	74.17002	74.11582	73.92963	73.86343	73.76124	5360
73.65904	73.58085	73.51465	73.42446	73.31026	73.29207	73.15387	[illegible]	72.91348	72.83529	5380
72.79309	72.59490	72.48070	72.31851	72.25231	72.21012	72.05992	71.99373	71.90353	71.83734	5400
71.77114	71.63295	71.53075	71.46456	71.37436	71.21217	71.13397	71.07978	71.03758	70.98339	5420
70.94119	70.80300	70.71280	70.67060	70.54441	70.45421	70.37602	70.33382	70.24363	70.16543	5440
70.09924	70.02104	69.93085	69.85265	69.73846	69.60026	69.55807	69.51387	69.42568	69.29948	5460
69.19729	69.15509	68.98090	68.93070	68.80051	68.77031	68.65612	68.50592	68.46373	68.39753	5480
68.29534	68.25314	68.13895	68.09675	67.93456	67.92836	67.79017	67.67597	67.62178	67.51958	5500
67.38139	67.24319	67.14100	67.03880	66.92461	66.81041	66.79222	66.72602	66.61183	66.47363	5520
66.35944	66.22124	66.22705	66.07685	65.96206	65.88446	65.72227	65.65607	65.56586	65.47568	5540
65.37349	65.33129	65.24110	65.15090	65.06071	64.99451	64.86832	64.75612	64.66393	64.58573	5560
64.54354	64.44134	64.32715	64.12895	64.07476	63.94856	63.88237	63.80417	63.70198	63.51578	5580
63.44959	63.39539	63.28120	63.22700	63.17281	63.07061	63.00442	62.98622	62.95003	62.74583	5600
62.76364	62.62544	62.55925	62.48105	62.41486	62.27666	62.16247	62.07227	61.89808	62.01188	5620
61.98169	62.23949	62.08930	61.98710	62.00491	62.01071	61.74052	61.54232	61.36813	61.26593	5640
61.10374	61.24154	61.12735	61.04915	60.92296	60.99276	60.97057	60.96437	60.87418	60.86798	5660
60.78979	60.93959	60.93340	61.02320	60.93300	60.83081	60.65661	60.48242	60.32022	60.14603	5680
60.07983	60.06164	59.93544	59.90525	59.88705	59.85685	59.86266	59.84447	59.89827	60.07208	5700
60.06588	60.03569	59.84949	59.65130	59.56110	59.43491	59.45271	59.26652	59.11632	58.91813	5720
58.82793	58.83374	58.62354	58.41335	58.26315	58.14896	58.02276	57.89657	57.78237	57.62018	5740
57.55393	57.46379	57.37359	57.36740	57.26520	57.24701	57.20481	57.10262	57.00042	56.87423	5760
56.68803	56.69384	56.55564	56.47745	56.32725	56.26106	56.14686	56.03267	56.05047	55.87628	5780
55.75008	55.56389	55.46169	55.40750	55.30530	55.29911	55.20891	55.11872	55.04052	54.99833	5800
54.93213	54.79394	54.65574	54.55355	54.49935	54.42116	54.33096	54.23277	54.15057	54.04838	5820
53.99418	53.87999	53.80179	53.74760	53.75340	53.63921	53.54901	53.41082	53.33252	53.24243	5840
53.11623	52.97804	52.85184	52.82165	52.65945	52.55726	52.50706	52.44887	52.38267	52.28048	5860
52.17828	52.02809	51.96189	51.82370	51.75750	51.59131	51.54111	51.43892	51.39672	51.28253	5880
51.16833	51.10214	50.98794	50.86175	50.74755	50.62136	50.53116	50.44097	50.44677	50.34458	5900
50.20638	50.09219	50.09799	49.94780	49.85760	49.83940	49.68921	49.59901	49.47282	49.38262	5920
49.34043	49.20223	49.12404	48.98584	48.93165	48.80545	48.70326	48.58906	48.43887	48.38467	5940
48.28248	48.20428	48.17409	47.99939	47.90970	47.83150	47.70531	47.57911	47.47692	47.33872	5960

TABLE IV - Continued

47.27253	47.18233	47.11614	47.04994	46.89975	46.84555	46.82736	46.66516	46.64697	46.54477	5980
46.53858	46.44836	46.29819	46.29199	46.20180	46.09960	46.00941	46.02721	45.91302	45.89482	6000
45.75663	45.71443	45.67224	45.51004	45.46785	45.32365	45.29945	45.24526	45.16707	45.11287	6020
45.03468	44.99248	44.91429	44.76409	44.66190	44.56370	44.49351	44.42731	44.37312	44.29492	6040
44.15673	44.07853	43.95234	43.83814	43.69995	43.54975	43.47156	43.33936	43.24317	43.10497	6060
42.93078	42.84056	42.70239	42.58819	42.46200	42.35980	42.19761	42.13741	41.93322	41.78302	6080
41.71683	41.57863	41.42844	41.31424	41.14005	40.97785	40.88766	40.73746	40.64727	40.48507	6100
40.38288	40.24468	40.14249	40.02829	39.92610	39.78790	39.64971	39.54751	39.44532	39.31912	6120
39.16893	39.09073	39.01254	38.94634	38.89215	38.77795	38.71176	38.73556	38.60337	38.52517	6140
38.42298	38.39278	38.35659	38.34439	38.26620	38.21200	38.13380	38.09161	38.08541	38.04322	6160
37.97702	37.93483	37.86863	37.88644	37.76024	37.71605	37.62785	37.58566	37.55546	37.42927	6180
37.33907	37.27288	37.21868	37.11649	37.01429	36.94810	36.85790	36.70771	36.66551	36.57532	6200
36.37712	36.29893	36.24473	36.08254	36.07634	35.91415	35.77595	35.63776	35.53556	35.39737	6220
35.27117	35.25298	35.11478	35.00059	34.86239	34.71223	34.57400	34.49581	34.33351	34.23142	6240
34.17722	34.03903	33.96083	33.85864	33.74444	33.61825	33.45605	33.35586	33.28766	33.20947	6260
33.08327	32.96908	32.84288	32.71669	32.59349	32.50030	32.41010	32.27191	32.20571	32.06752	6280
31.96532	31.86313	31.73693	31.65874	31.59254	31.49035	31.43615	31.33396	31.30376	31.23757	6300
31.12397	31.05716	31.95498	30.88679	30.71459	30.62440	30.57020	30.49201	30.41381	30.31162	6320
30.24542	30.15523	30.08903	29.90284	29.76464	29.65045	29.52425	29.47036	29.37986	29.24167	6340
29.11547	29.00128	28.89908	28.90489	28.77469	28.73650	28.67030	28.53811	28.30191	28.36372	6360
28.28552	28.19533	28.11713	28.08694	28.04474	27.90655	27.81635	27.75016	27.57536	27.50377	6380
27.33557	27.28138	27.21518	27.08899	27.01379	26.95660	26.81840	26.65620	26.60201	26.43981	6400
26.43362	26.30742	26.25323	26.12703	26.06084	25.98264	25.90445	25.85025	25.79606	25.72986	6420
25.63967	25.57347	25.48328	25.51308	25.43489	25.34469	25.20650	25.05630	25.01411	24.91191	6440
24.84572	24.77952	24.72533	24.61113	24.48494	24.43074	24.36455	24.26635	24.16016	24.14196	6460
23.94377	23.87757	23.75138	23.67318	23.59499	23.43279	23.33060	23.13240	23.12621	22.97601	6480
22.82582	22.73562	22.62143	22.47123	22.33304	22.29084	22.16465	22.05045	21.93626	21.79806	6500
21.73187	21.62967	21.51548	21.44928	21.35909	21.26889	21.13070	21.07650	20.97431	20.86011	6520
20.78192	20.78372	20.51753	20.37933	20.22914	20.11494	20.07275	19.97055	19.84436	19.70616	6540
19.65197	19.57377	19.51958	19.44138	19.37519	19.30899	19.19480	19.10460	19.01441	18.92421	6560
18.88202	18.79182	18.67763	18.57543	18.46124	18.39504	18.28085	18.23265	18.11246	17.96226	6580
17.84807	17.68587	17.66768	17.52948	17.45129	17.34909	17.24690	17.16870	17.07851	16.98831	6600
16.87412	16.74792	16.69373	16.53153	16.40534	16.29114	16.15295	16.02675	15.92456	15.85836	6620
15.76817	15.66597	15.63578	15.55758	15.49139	15.40119	15.26300	15.14880	15.08260	14.93241	6640
14.77821	14.58482	14.42182	14.34363	14.24143	14.18724	14.12184	14.03685	13.95265	13.87446	6660
13.84426	13.67807	13.57987	13.48968	13.32748	13.24929	13.05189	13.03290	12.98678	12.72851	6680
12.58231	12.51612	12.32992	12.27573	12.12553	12.18734	12.94614	11.73495	11.68075	11.67456	6700
11.58436	11.48217	11.34397	11.25378	11.21158	11.10939	11.04319	10.97700	10.97080	10.98461	6720
10.82641	10.76622	10.66202	10.51983	10.41763	10.39944	10.30924	10.25505	10.14085	10.15866	6740
10.11646	10.07427	9.98407	9.94188	9.86368	9.71349	9.62329	9.53310	9.55030	9.47271	6760
9.44251	9.35832	9.27412	9.17193	9.10573	8.97954	8.80934	8.84715	8.75635	8.73876	6780
8.78856	8.59437	8.50417	8.46198	8.44378	8.35359	8.32339	8.22120	8.16700	8.13681	6800
8.02261	7.98042	7.87822	7.82403	7.78183	7.75164	7.67344	7.65525	7.57705	7.55886	6820
7.49266	7.42647	7.39627	7.29408	7.21588	7.12569	7.08349	7.08930	7.07118	7.07691	6840
6.99871	6.94452	6.97432	6.90813	6.86593	6.79974	6.73354	6.67935	6.61315	6.53496	6860
6.49276	6.43857	6.38437	6.31818	6.28798	6.28979	6.17959	6.10140	6.04720	5.99300	6880
5.97481	5.94461	5.91442	5.86022	5.75803	5.69183	5.63764	5.55944	5.45725	5.42705	6900
5.34886	5.25866	5.18047	5.15027	5.09608	4.33388	4.93969	4.87349	4.78330	4.69318	6920
4.65091	4.58471	4.54252	4.51232	4.42213	4.33193	4.24174	4.17554	4.12135	4.04315	6940
3.97696	3.92276	3.88057	3.86237	3.78418	3.76598	3.69979	3.71759	3.65140	3.65720	6960

TABLE IV - Continued

3.63901	3.63281	3.59062	3.53642	3.49423	3.45203	3.38584	3.41364	3.34945	3.36725	6980
3.34906	3.34286	3.31267	3.31847	3.24026	3.25808	3.16769	3.15569	3.16750	3.17330	7000
3.09511	3.07691	3.14272	3.07652	3.01033	2.98013	2.93794	2.83374	2.87755	2.85335	7020
2.82916	2.83496	2.81677	2.79857	2.79238	2.75018	2.73199	2.70179	2.65960	2.65340	7040
2.65921	2.64101	2.61082	2.64062	2.64643	2.66423	2.65804	2.63984	2.65765	2.57945	7060
2.56126	2.54306	2.51287	2.48267	2.42848	2.45628	2.42809	2.39789	2.40370	2.33750	7080
2.27131	2.27711	2.27092	2.30072	2.23453	2.31233	2.23414	2.22794	2.19775	2.23955	7100
2.20936	2.22716	2.14897	2.20277	2.16358	2.14238	2.13619	2.03399	2.05180	2.00960	7120
2.06340	2.08121	2.05101	2.04482	1.97862	1.97243	2.00223	2.03234	2.01384	2.03165	7140
2.01345	2.06726	2.10906	2.13887	2.12067	2.11448	2.07228	2.09009	2.03589	2.01770	7160
2.01150	1.90931	1.91511	1.92092	1.85472	1.80053	1.78233	1.75414	1.72194	1.70375	7180
1.63755	1.66736	1.63716	1.54697	1.57677	1.51058	1.51638	1.45219	1.44399	1.41350	7200
1.37160	1.38941	1.29921	1.31702	1.34682	1.32863	1.33443	1.22024	1.22604	1.17185	7220
1.21365	1.14746	1.22526	1.19507	1.14087	1.11068	1.15248	1.17029	1.12809	1.15790	7240
1.16370	1.16951	1.16331	1.10912	1.09092	1.09673	1.04253	1.06034	1.00614	1.02395	7260
1.01775	1.01156	1.01736	1.02317	1.05297	1.10678	1.06458	1.09439	1.11219	1.07000	7280
1.06380	1.03361	1.03941	1.02122	1.02702	1.06883	1.03863	1.04444	1.00224	.93605	7300
.98985	1.03166	.96546	.93527	.85707	.80288	.77268	.73049	.68829	.64610	7320
.62790	.64571	.63951	.63332	.55512	.56093	.50673	.45454	.45834	.40415	7340
.34995	.24776	.26556	.18737	.14517	.12698	.08478	.05659	.06039	.01820	7360
-.01200	-.01820	-.04839	-.06659	-.03678	-.06598	-.10917	-.11537	-.10956	-.16376	7380
-.19395	-.20015	-.27834	-.34454	-.39873	-.40493	-.44712	-.42932	-.42351	-.39371	7400
-.45990	-.45410	-.46029	-.50249	-.54468	-.59688	-.62107	-.70727	-.71346	-.74366	7420
-.76185	-.78005	-.76224	-.74444	-.75063	-.75683	-.77502	-.72122	-.75141	-.69761	7440
-.69180	-.72200	-.70419	-.71039	-.75258	-.81878	-.83697	-.87917	-.92136	-.92756	7460
-.95775	-.99995	-.99414	-1.06034	-1.06653	-1.07273	-1.13892	-1.13312	-1.16331	-1.15751	7480
-1.15170	-1.14590	-1.10409	-1.14629	-1.14048	-1.19468	-1.22487	-1.25507	-1.28525	-1.30346	7500
-1.30965	-1.27985	-1.27464	-1.22024	-1.22643	-1.23263	-1.25082	-1.25742	-1.27521	-1.29341	7520

********** END RUNWAY DATA ********** LD1= 3761

TABLE V - Airplane Data for Sample Problem

****************** INPUT DATA ******************

********** GENERAL AIRCRAFT DATA **********

Class C Aircraft

W=	306000.0	WW=	1659.3.	WN=	432.00	A=	30.000	B=	670.300	HMI=	0.736006.
SXM=	2.0	SXN=	1.2	SLM=	91.0	SLN=	91.9	PSARM=	757.6	TAILRM=	637.9
AAM=	78.67	AMM=	96.89	PAOM=	243.00	VOM=	1016.60	OAM=	3.14	TSM =	25050.0.
AAN=	19.64	AMN=	13.91	PAON=	265.00	VON=	335.90	OAN=	1.23	TSN =	13003.86
CL=	.603	CD=	.033	AREA=	2090.0	SPEED=	1.0	THRUST=	40000.	TAKOFF=	299.00

STROKE NOSE	PIN DIAMETER
0.000	1.160
1.603	1.130
4.193	1.130
11.690	1.170
13.150	1.170
15.400	1.265
50.000	1.265

STROKE MAIN	PIN DIAMETER
0.000	1.567
3.750	1.567
6.750	1.517
7.750	1.517
9.000	1.567
10.650	1.503
11.500	1.500
21.790	1.979
50.000	1.979

TABLE V - Continued

MODE	SIPS	SINOSE	SICG	SIMAIN	SITAIL	OMEGA	GEN. MASS
1	-.02	-.03	-.09	-.13	-.21	8.22	29.5
2	.18	.15	.03	.11	.02	12.76	42.5
3	.09	.07	.01	.01	.05	14.62	113.3
4	.55	.45	-.03	-.02	.43	15.74	131.7
5	.54	.46	-.11	-.13	.36	17.91	47.3
6	-.07	-.06	-.03	-.03	.07	20.58	43.1
7	-.29	-.20	.15	.13	-.15	23.69	27.0
8	-.09	-.05	.01	.10	-.05	33.80	2.3
9	.16	.09	-.09	-.17	.07	41.15	43.1
10	.09	.05	-.05	-.15	.05	41.90	19.5

********* INTIAL CONDITIONS ************

ZMI= -5.849 ZNI= -.997 THETAI= -.021125 ZCGI= -25.318

XMAIN= -20.133 XNOSE= -9.399 RCACTN= -12966. REACTN= -293834.

TABLE VI - Typical Page of Tested Output Taken from the Results of the Sample Problem

AMAIN	ADUSE	F3A	F3N	TAILAC	SPEED	DIST.	C3ACC	PSA	TIME
-13.936	[illegible]	[illegible]	-9341.	.047	100.330	162.130	.042	-.032	1.62
[illegible]	[illegible]	-263814.	-9831.	[illegible]	[illegible]	164.130	.141	-.032	1.64
[illegible]	[illegible]	-263308.	-9939.	.177	[illegible]	166.130	.073	.046	1.66
[illegible]	[illegible]	[illegible]	-9130.	.211	[illegible]	168.130	.067	.034	1.68
[illegible]	[illegible]	-287133.	-9041.	.239	[illegible]	170.130	.021	.082	1.70
[illegible]	[illegible]	-266758.	-9137.	.252	[illegible]	172.130	.013	.102	1.72
[illegible]	[illegible]	[illegible]	-9344.	.243	[illegible]	174.130	-.015	.097	1.74
[illegible]	[illegible]	-277745.	-8793.	.219	[illegible]	176.130	-.022	.065	1.76
[illegible]	[illegible]	-279924.	-9873.	.180	[illegible]	178.130	-.041	.087	1.78
[illegible]	[illegible]	-270204.	[illegible]	.134	100.330	180.130	[illegible]	-.078	1.80
[illegible]	[illegible]	-273028.	-9309.	.087	[illegible]	182.130	.043	-.151	1.82
[illegible]	[illegible]	-275477.	-8739.	.058	[illegible]	184.130	.074	-.188	1.84
-13.926	[illegible]	-273295.	-9139.	.029	[illegible]	186.130	.066	-.227	1.86
-13.911	[illegible]	-271333.	-9401.	.021	[illegible]	188.130	.049	-.204	1.88
[illegible]	[illegible]	[illegible]	-9839.	.015	[illegible]	190.130	-.019	-.138	1.90
-13.707	[illegible]	[illegible]	-9218.	[illegible]	[illegible]	192.130	-.042	-.138	1.92
-13.736	[illegible]	[illegible]	-9340.	[illegible]	[illegible]	194.130	-.073	-.097	1.94
[illegible]	[illegible]	[illegible]	-9771.	[illegible]	100.330	196.130	-.103	-.054	1.96
[illegible]	[illegible]	[illegible]	-9147.	-.317	[illegible]	198.130	-.113	-.079	1.98
-13.649	[illegible]	-252452.	-8432.	-.024	[illegible]	200.130	-.146	-.072	2.00
[illegible]	[illegible]	[illegible]	-9733.	-.039	[illegible]	202.130	-.174	-.075	2.02
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	204.130	-.073	-.123	2.04
[illegible]	[illegible]	[illegible]	-9313.	-.077	[illegible]	206.130	[illegible]	-.152	2.06
[illegible]	[illegible]	[illegible]	-9263.	-.086	[illegible]	208.130	-.028	-.164	2.08
[illegible]	[illegible]	-2?4973.	-9792.	-.077	[illegible]	210.130	-.037	-.188	2.10
[illegible]	[illegible]	[illegible]	[illegible]	-.075	[illegible]	212.130	-.044	-.133	2.12
-13.716	[illegible]	-238135.	[illegible]	-.063	[illegible]	214.130	[illegible]	-.139	2.14
-13.769	[illegible]	-233172.	-9313.	-.040	[illegible]	216.130	-.023	-.118	2.16
[illegible]	[illegible]	[illegible]	-9999.	-.020	[illegible]	218.130	[illegible]	-.089	2.18
[illegible]	[illegible]	-260393.	-11791.	[illegible]	[illegible]	220.130	-.056	-.015	2.20
[illegible]	[illegible]	-230025.	[illegible]	.018	[illegible]	222.130	-.073	-.087	2.22
[illegible]	[illegible]	[illegible]	[illegible]	.025	[illegible]	224.130	-.068	.006	2.24
[illegible]	[illegible]	-259443.	-11118.	.023	100.330	226.130	[illegible]	.023	2.26
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	228.130	-.041	-.012	2.28
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	230.130	-.013	[illegible]	2.30
[illegible]	[illegible]	-273758.	-11373.	-.007	[illegible]	232.130	.015	-.060	2.32
[illegible]	[illegible]	-279280.	-12441.	[illegible]	[illegible]	234.130	.059	-.077	2.34
[illegible]	[illegible]	-263396.	-12302.	[illegible]	[illegible]	236.130	[illegible]	-.071	2.36
[illegible]	[illegible]	-239621.	[illegible]	[illegible]	[illegible]	238.130	.087	-.054	2.38
[illegible]	[illegible]	[illegible]	-13027.	.043	[illegible]	240.130	.105	-.012	2.40
[illegible]	[illegible]	[illegible]	-14273.	.074	[illegible]	242.130	.075	.072	2.42
[illegible]	-10.727	-293139.	-14370.	[illegible]	[illegible]	244.130	.072	.134	2.44
[illegible]	[illegible]	-299910.	-14304.	.123	[illegible]	246.130	[illegible]	.161	2.46
[illegible]	[illegible]	[illegible]	-13523.	.142	100.330	248.130	.044	.225	2.48
[illegible]	[illegible]	[illegible]	-13371.	.139	[illegible]	250.130	.022	.234	2.50
[illegible]	[illegible]	-294734.	-13591.	.129	[illegible]	252.130	[illegible]	.220	2.52
[illegible]	[illegible]	-291332.	[illegible]	[illegible]	[illegible]	254.130	.043	.192	2.54
[illegible]	[illegible]	[illegible]	-13478.	.073	[illegible]	256.130	.071	.168	2.56
[illegible]	[illegible]	-291476.	-13413.	.033	[illegible]	258.130	[illegible]	.103	2.58
[illegible]	[illegible]	[illegible]	-13221.	[illegible]	[illegible]	260.130	.127	.031	2.60
[illegible]	[illegible]	[illegible]	[illegible]	-.024	100.330	262.130	.121	.006	2.62
[illegible]	[illegible]	-293074.	[illegible]	-.027	[illegible]	264.130	.136	[illegible]	2.64
[illegible]	[illegible]	[illegible]	-13606.	-.025	[illegible]	266.130	.065	.037	2.66
[illegible]	[illegible]	-286379.	[illegible]	-.014	[illegible]	268.130	.051	.079	2.68
[illegible]	[illegible]	-287693.	[illegible]	-.013	[illegible]	270.130	[illegible]	.057	2.70
[illegible]	[illegible]	-283930.	[illegible]	-.002	[illegible]	272.130	.019	.094	2.72
[illegible]	[illegible]	-279278.	-13921.	[illegible]	[illegible]	274.130	[illegible]	.156	2.74
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	276.130	-.043	.136	2.76
[illegible]	[illegible]	-275527.	-13493.	[illegible]	[illegible]	278.130	-.048	.122	2.78
[illegible]	[illegible]	-273686.	[illegible]	-.042	[illegible]	280.130	-.036	.089	2.80
[illegible]	[illegible]	[illegible]	-13521.	[illegible]	[illegible]	282.130	-.032	.062	2.82
[illegible]	[illegible]	[illegible]	-13531.	-.396	[illegible]	284.130	[illegible]	.015	2.84
[illegible]	[illegible]	[illegible]	[illegible]	-.128	[illegible]	286.130	-.043	[illegible]	2.86
[illegible]	[illegible]	[illegible]	-13920.	-.147	[illegible]	288.130	[illegible]	-.003	2.88
[illegible]	[illegible]	-259938.	-13291.	-.174	[illegible]	290.130	-.014	-.071	2.90
[illegible]	[illegible]	[illegible]	-13539.	-.173	[illegible]	292.130	[illegible]	[illegible]	2.92
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	294.130	-.032	[illegible]	2.94
[illegible]	[illegible]	-257313.	-13273.	[illegible]	[illegible]	296.130	-.047	-.028	2.96
[illegible]	[illegible]	[illegible]	[illegible]	-.131	[illegible]	298.130	[illegible]	.018	2.98
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	300.130	-.051	[illegible]	3.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	302.130	[illegible]	.044	3.02
[illegible]	[illegible]	[illegible]	[illegible]	-.082	[illegible]	304.130	-.053	.026	3.04
[illegible]	[illegible]	[illegible]	[illegible]	-.075	[illegible]	306.130	-.067	.021	3.06
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	308.130	-.052	.025	3.08
[illegible]	[illegible]	[illegible]	-14167.	[illegible]	[illegible]	310.130	-.051	[illegible]	3.10
[illegible]	[illegible]	[illegible]	-14393.	[illegible]	[illegible]	312.130	[illegible]	-.023	3.12
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	314.130	[illegible]	-.025	3.14
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	316.130	[illegible]	[illegible]	3.16
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	318.130	-.013	[illegible]	3.18
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	320.130	-.025	.027	3.20
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	322.130	-.041	-.017	3.22

SECTION V

RESULTS

The mathematical model and computer program presented in this report is capable of simulating five classes of commercial jet aircraft. Classification is made on the basis of gross weight as follows:

Class A	Less than 150,000 lb
Class B	150,000 - 300,000 lb
Class C	300,000 - 450,000 lb
Class D	450,000 - 600,000 lb
Class E	Greater than 600,000 lb

The data used to represent these aircraft and typical simulations using the data for each class of aircraft is presented in this section.

The data set for each aircraft class contains a general configuration, (Figures 8, 11, 14, 17, and 20), a description of input variable fortran names, (Tables VII, IX, XI, XIII, and XV), two pages of input data (Tables VIII, X, XII, XIV, and XVI), and a set of tire deflection curves, (Figures 9, 10, 12, 13, 15, 16, 18, 19, 21, and 22), for both main and nose landing gears. The first page of input data contains all of the rigid body airplane and landing gear data. The second page of data contains the aircraft's modal data and the aircraft's initial conditions as computed by TAXI.

The aircraft data presented was used to simulate each aircraft taking off from two separate profiles, Will Rogers International and Dulles International Airports. The calcomp plotted results are shown in Figures 23 through 32. It is evident that all airplanes responded to the prominent bump which occurred at approximately 2700 feet on the Will Rogers profile, although some to larger degree than others. With the exception of this one bump it is difficult to correlate runway roughness to the response of all aircraft. Some airplanes responded to a certain section of a profile while others did not. Some airplanes responded predominately in pitch such as the Class C and D aircraft while others responded in pitch and plunge such as the Class A and B aircraft. This points out the significance of such parameters as gear stiffness, degree of coupling between the rigid body modes, gear spacing and others.

For all aircraft classes except Class B the rms value of the Pilot's station vertical acceleration was less over the Dulles profile than that of the Will Rogers profile. For all aircraft classes except Class B and

D, the center of gravity vertical acceleration rms level is less for the Dulles profile. For these three exceptions, the rms level was the same for both profiles. From a purely response standpoint then, it can be said that the Dulles International runway profile is smoother than the Will Rogers International profile.

Figures 33 and 34 show the difference in response of Class B aircraft with and without strut bearing friction included in the simulation. The simulation for both runs were at a constant speed of 100 feet per second over the Will Rogers profile. The center of gravity rms level was increased with the inclusion of strut friction while it was reduced slightly at the pilot's station. The jerky motion evidenced by the response at the cg was expected and was caused by the constant "locking up" of the struts due to the binding forces on the upper and lower bearing surfaces of the landing gear struts. It is more evident at the cg because most of the aircraft's weight, and resulting strut forces, is on the main landing gear which is closest to the aircraft's cg.

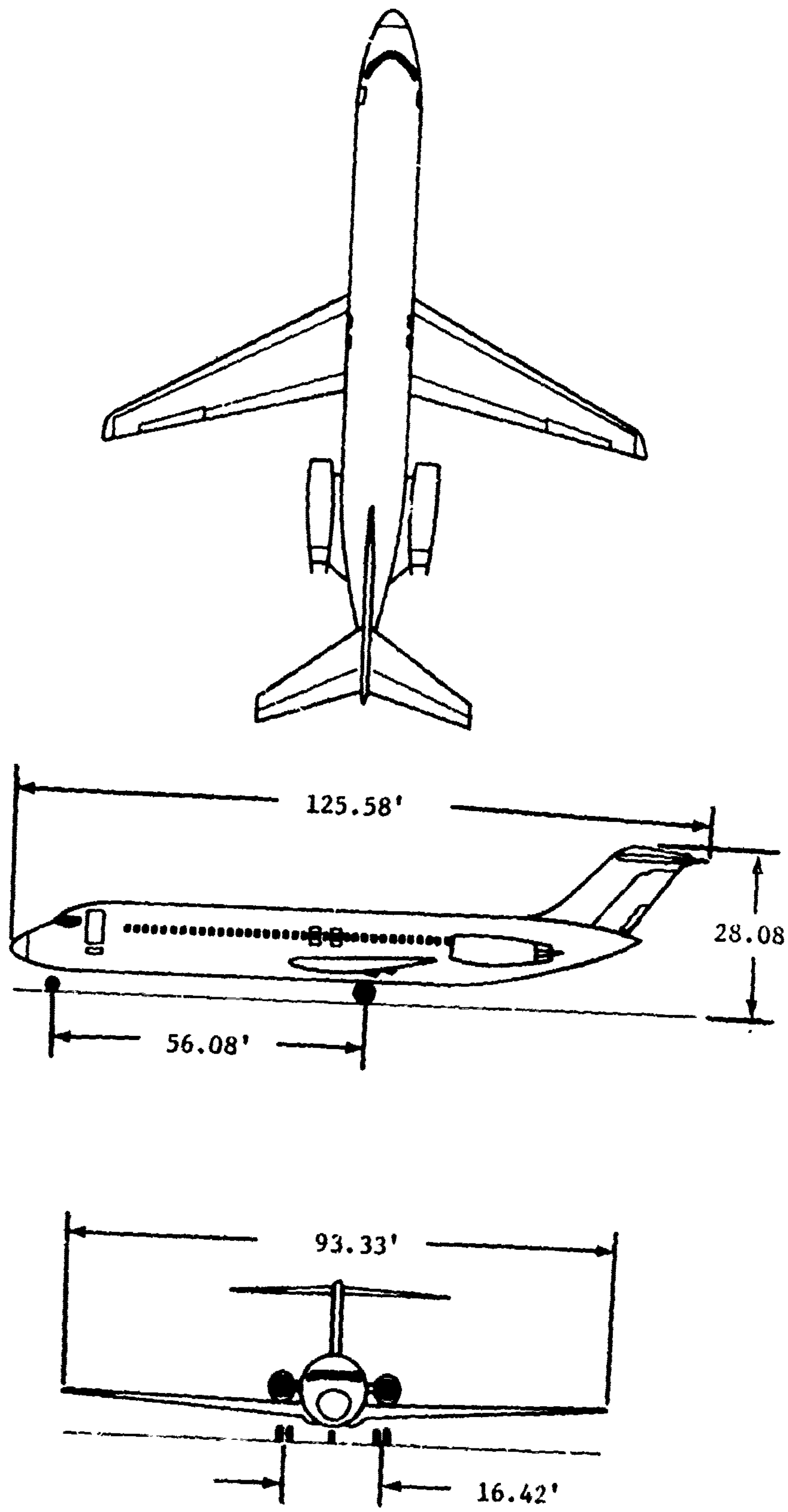


Figure 8 - Class A Aircraft General Configuration

TABLE VII - List of Input Data Fortran Names

```
**************************************************************TAXI0520
C        READ AND PRINT INPUT DATA                              TAXI0530
**************************************************************TAXI0540
C   W=VEHICLE WEIGHT AT CG (POUNDS)                             TAXI0550
C   A=DISTANCE MAIN GEAR TO CG (INCHES)                         TAXI0560
C   B=DISTANCE NOSE GEAR TO CG (INCHES)                         TAXI0570
C RMI=MASS MOMENT OF INERTIA (LB IN SEC SQ)                     TAXI0580
C  PLANE= AIRPLANE BEING SIMULATED AND  GROSS WEIGHT            TAXI0590
C  PSARM = DISTANCE OF PILOT STATION TO CG                      TAXI0600
C      TAILRM = DISTANCE OF TAIL STATION TO CG                  TAXI0610
C  TAKOFF= TAKE-OFF SPEED (FEET/SEC)                            TAXI0620
C SPEED =INITIAL  VEL  OF  AIRPLANE                             TAXI0630
C  THURST= TOTAL AIRPLANE THRUST                                TAXI0640
C  CL=LIFT COEFF.                                               TAXI0650
C  AREA=WING AREA                                               TAXI0660
C  CD=DRAG COEFF.                                               TAXI0670
C  WM=WEIGHT OF MAIN GEAR  (EACH)                               TAXI0680
C  WN=WEIGHT OF NOSE GEAR                                       TAXI0690
C  SXM= NUMBER OF MAIN GEAR STRUTS                              TAXI0700
C   SXN= NUMBER OF NOSE GEAR STRUTS                             TAXI0710
C AHN  HYDRAULIC PISTON AREA NOSE SQ INCHES                     TAXI0720
C AAN  PNEUMATIC PISTON AREA NOSE SQ INCHES                     TAXI0730
C AHM  HYDRAULIC PISTON AREA MAIN SQ INCHES                     TAXI0740
C AAM  PNEUMATIC PISTON AREA MAIN SQ INCHES                     TAXI0750
C PAON NOSE STRUT PRELOAD PRESSURE  PSI                         TAXI0760
C PAOM MAIN STRUT PRELOAD PRESSURE  PSI                         TAXI0770
C VON  NOSE STRUT INITIAL VOLUME CU. IN.                        TAXI0780
C VOM  MAIN STRUT INITIAL VOLUME CU. IN.                        TAXI0790
C OAM  ORIFACE AREA MAIN                                        TAXI0800
C OAN  ORIFACE AREA NOSE                                        TAXI0810
C SLM=MAIN GEAR STRUT LENGTH UNLOADED INCHES                    TAXI0820
C      DISTANCE FROM CL OF AXLE TO CG LINE                      TAXI0830
C SLN=NOSE GEAR STRUT LENGTH UNLOADED INCHES                    TAXI0840
C      DISTANCE FROM CL OF AXLE TO CG LINE                      TAXI0850
C  TSM     MAIN TIRE SPRING CONSTANT PER STRUT                  TAXI0860
C  TSN     NOSE TIRE SPRING CONSTANT PER STRUT                  TAXI0870
C  DX=TIME STEP SIZE                                            TAXI0880
C  IFPLOT   NO PLOT IF IFPLOT =1.                               TAXI0890
C  IFLIST   NO LIST IF IFLIST =1.                               TAXI0900
C  READ METERING PIN DESCRIPTION STARTING AT ZERO STROKE        TAXI0910
C  NSCN=# OF METERING PIN CHANGES NOSE GEAR                     TAXI0920
C  NSCM=# OF METERING PIN CHANGES MAIN GEAR                     TAXI0930
C  NFM = NUMBER OF FLEXIBLE MODES                               TAXI0940
C  SIXXXX(I) = MODE SHAPE DEFLECTION (NON DIM.)                 TAXI0950
C  GM(I) = GENERALIZED MASS (POUNDS-SEC SQ/IN)                  TAXI0960
C  OMEGA (I) = MODAL FREQUENCIES (RAD/SEC)                      TAXI0970
```

TABLE VIII - List of Data Used to Simulate Class A Aircraft

****************** INPUT DATA ******************

********* GENERAL AIRCRAFT DATA *********

Class A 114000 POUNDS GROSS WEIGHT 35 % MAC

W=	114000.0	WM=	1074.00	WN=	164.00	A=	24.430	B=	652.430	MMI=	21540000.
SXM=	2.0	SXN=	1.0	SLM=	97.9	SLN=	96.7	PSARM=	660.5	TAILRM=	513.0
AAM=	25.92	AHM=	20.61	PAOM=	332.00	VOM=	462.20	OAM=	.69	TSM =	25000.00
AAN=	8.20	AHN=	6.30	PAON=	120.30	VON=	126.66	OAN=	.42	TSN =	10320.00
CL=	.698	CD=	.065	AREA=	1000.70	SPEED=	1.0	THRUST=	23600.	TAKOFF=	205.00

STROKE NOSE	PIN DIAMETER
0.000	.375
.545	.639
6.925	.684
12.425	.723
15.075	.723
15.147	.723

STROKE MAIN	PIN DIAMETER
0.000	.421
.600	.421
1.500	.569
3.500	.641
8.000	.760
13.500	.826
17.000	.826

TABLE VIII - Continued

MODE	SIPS	SINOSE	SICG	SIMAIN	SITAIL	OMEGA	GEN. MASS
1	-.06	-.06	-.03	-.01	-.07	10.50	4.3
2	.10	.09	-.03	-.03	.02	26.10	1.4
3	-.32	-.30	.10	.12	-.12	33.90	0.6
4	-.12	-.11	.01	.02	-.27	43.90	3.5
5	-.05	-.04	.04	.01	-.01	53.60	2.0
6	.12	.11	-.04	-.03	.11	56.90	32.7
7	-.04	-.04	.01	-.00	-.05	57.30	5.3
8	.25	.23	-.02	.01	.09	71.60	7.2
9	-.01	-.01	-.00	-.01	-.02	95.50	1.4
10	.09	.00	-.01	-.04	-.06	111.00	3.4
11	-.07	-.06	-.04	.03	.21	116.00	3.6

********* INTIAL CONDITIONS ************

ZWI= -2.190 ZNI= -.399 THETAI= -.007067 ZCGI= -16.000

XMAIN= -14.975 XNOSE= -11.449 REACTN= -4115. REACTM= -109885.

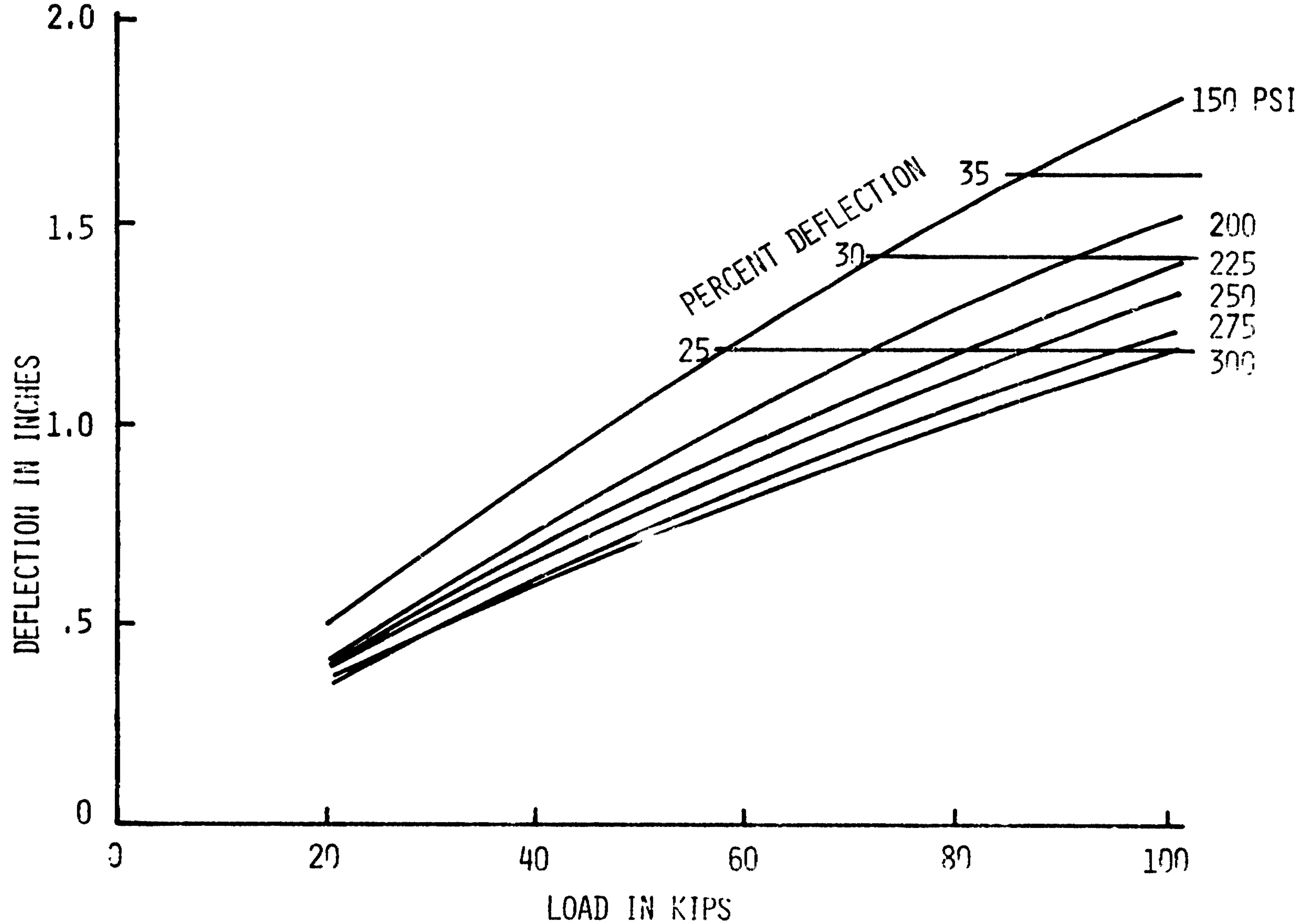


Figure 9 - Class A Aircraft Nose Landing Gear Tire Deflection Curves

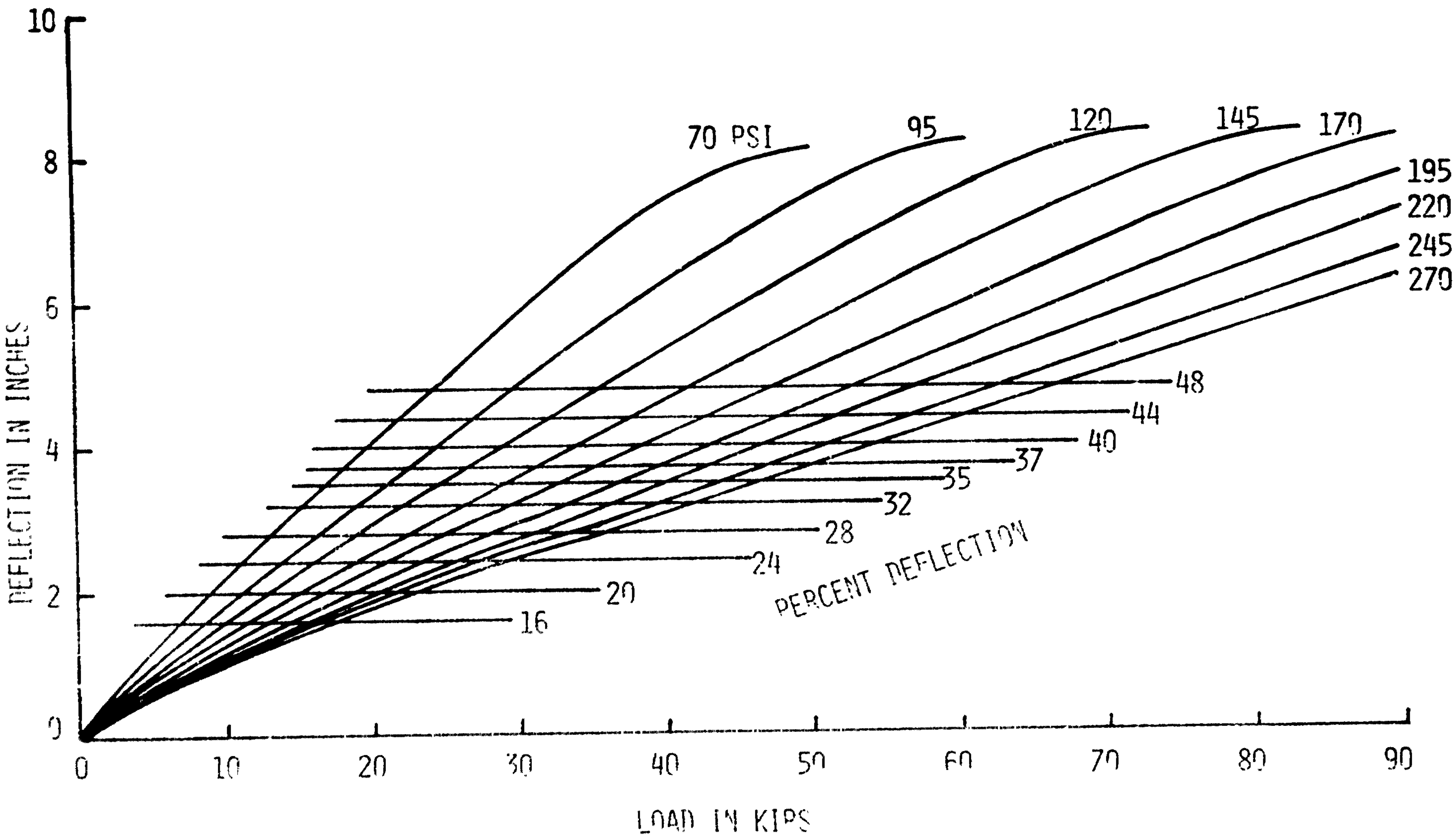


Figure 10 - Class A Aircraft Main Landing Gear Tire Deflection Curves

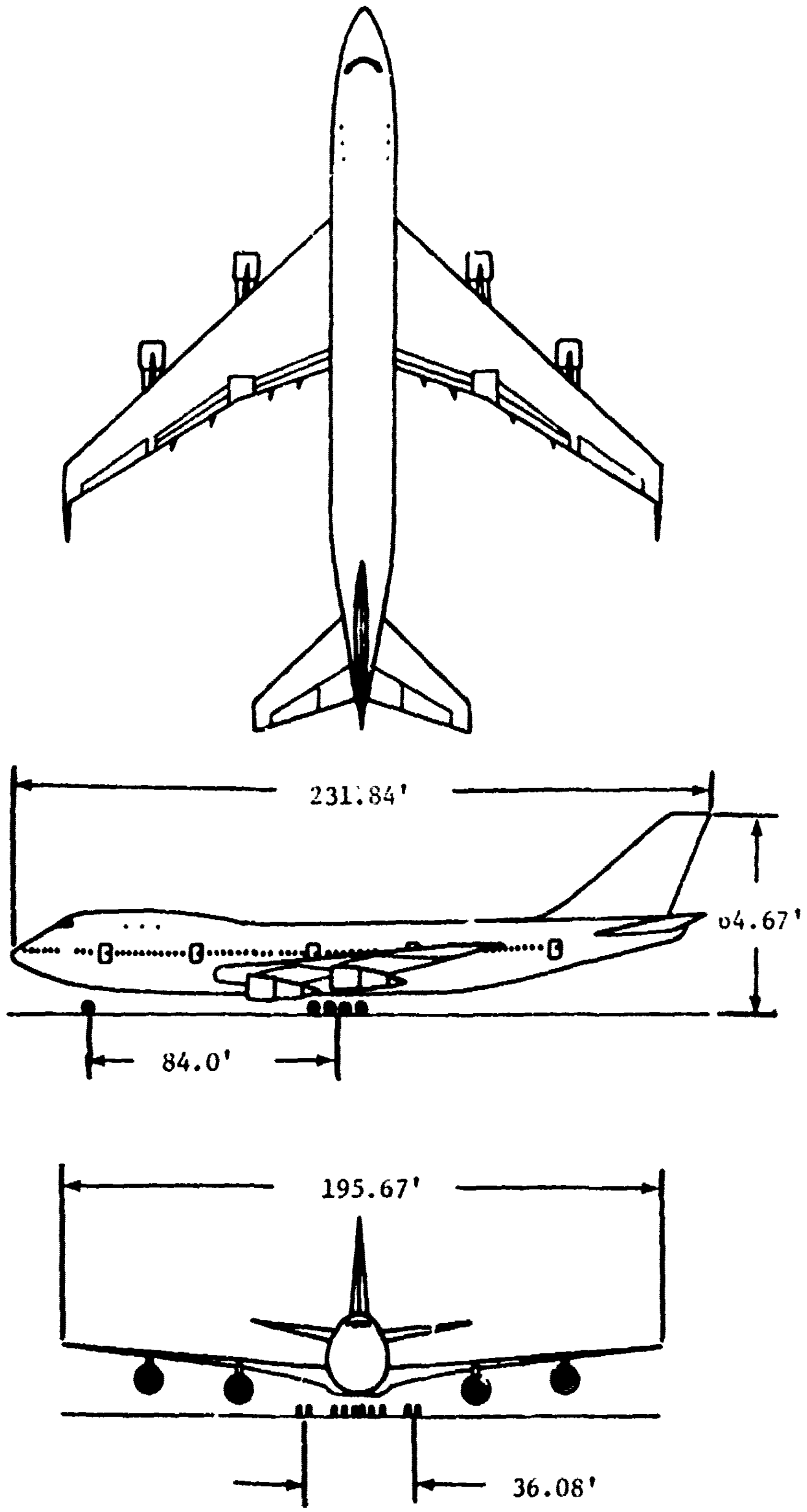


Figure 11 - Class E Aircraft General Configuration

TABLE IX - List of Input Data Fortran Names

PROGRAM TAXI

```
*****************************************************************TAXI0580
C         READ AND PRINT INPUT DATA                               TAXI0590
*****************************************************************TAXI0600
C    W=VEHICLE WEIGHT AT CG (POUNDS)                              TAXI0610
C    A=DISTANCE MAIN GEAR TO CG (INCHES)                          TAXI0620
C    B=DISTANCE NOSE GEAR TO CG  INCHES)                          TAXI0630
C  C  DISTANCE REAR MAIN TO CG (INCHES)                           TAXI0640
C MMI=MASS MOMENT OF INERTIA (LB IN SEC SQ)                       TAXI0650
C  PLANE= AIRPLANE BEING SIMULATED AND  GROSS WEIGHT              TAXI0660
C  PSARM = DISTANCE OF PILOT STATION TO CG                        TAXI0670
C      TAILRM = DISTANCE OF TAIL STATION TO CG                    TAXI0680
C  TAKOFF= TAKE-OFF SPEED (FEET/SEC)                              TAXI0690
C SPEED =INITIAL  VEL  OF  AIRPLANE                               TAXI0700
C  THURST= TOTAL AIRPLANE THRUST                                  TAXI0710
C  CL=LIFT COEFF.                                                 TAXI0720
C  AREA=WING AREA                                                 TAXI0730
C  CD=DRAG COEFF.                                                 TAXI0740
C  WM=WEIGHT OF MAIN GEAR  (EACH)                                 TAXI0750
C  WN=WEIGHT OF NOSE GEAR                                         TAXI0760
C  WRM=UNSPRUNG WEIGHT OF EACH REAR MAIN LANDING GEAR             TAXI0770
C  SXM= NUMBER OF MAIN GEAR STRUTS                                TAXI0780
C    SXN= NUMBER OF NOSE GEAR STRUTS                              TAXI0790
C AHN  HYDRAULIC PISTON AREA NOSE SQ INCHES                       TAXI0800
C AAN  PNEUMATIC PISTON AREA NOSE SQ INCHES                       TAXI0810
C  AHRM= HYDRAULIC AREA OF REAR MLG                               TAXI0820
C    AARM= PNEUMATIC PISTON AREA OF REAR MLG                      TAXI0830
C AHM  HYDRAULIC PISTON AREA MAIN SQ INCHES                       TAXI0840
C AAM  PNEUMATIC PISTON AREA MAIN SQ INCHES                       TAXI0850
C PAON NOSE STRUT PRELOAD PRESSURE  PSI                           TAXI0860
C PAOM MAIN STRUT PRELOAD PRESSURE  PSI                           TAXI0870
C  PAORM= FULLY EXTENDED PRESSURE OF REAR MLG                     TAXI0880
C VON  NOSE STRUT INITIAL VOLUME CU. IN.                          TAXI0890
C VOM  MAIN STRUT INITIAL VOLUME CU. IN.                          TAXI0900
C   VORM=  FULLY EXTENDED VOLUME OF REAR MLG                      TAXI0910
C OAM  ORIFACE AREA MAIN                                          TAXI0920
C OAN  ORIFACE AREA NOSE                                          TAXI0930
C  OARM= REAR MLG ORIFICE AREA                                    TAXI0940
C SLM=MAIN GEAR STRUT LENGTH UNLOADED INCHES                      TAXI0950
C      DISTANCE FROM CL OF AXLE TO CG LINE                        TAXI0960
C SLN=NOSE GEAR STRUT LENGTH UNLOADED INCHES                      TAXI0970
C      DISTANCE FROM CL OF AXLE TO CG LINE                        TAXI0980
C  TSM    MAIN TIRE SPRING CONSTANT PER STRUT                     TAXI0990
C  TSN    NOSE TIRE SPRING CONSTANT PER STRUT                     TAXI1000
C   TSRM   REAR MLG TIRE SPRING CONSTANT                          TAXI1010
C  DT=TIME STEP SIZE                                              TAXI1020
C  IFPLOT   NO PLOT IF IFPLOT =1.                                 TAXI1030
C  IFLIST   NO LIST IF IFLIST =1.                                 TAXI1040
C  READ METERING PIN DESCRIPTION STARTING AT ZERO STROKE          TAXI1050
C  NSCN  OF METERING PIN CHANGES NOSE GEAR                        TAXI1060
C  NSCM  OF METERING PIN CHANGES MAIN GEAR                        TAXI1070
C  NSCRM   # OF SLOPE CHANGES FOR REAR MLG METERING PIN           TAXI1080
C   PIN (#), (#),  MAKE UP THE METERING PIN TABLES                TAXI1090
C  NFM                                                            TAXI1100
                          DEFLECTION (NOT IN.)                    TAXI1110
                       MASS (POUNDS-SEC                           TAXI1120
                                                                  TAXI1130
                                                                  TAXI1140
```

TABLE X - List of Data Used to Simulate Class E Aircraft

***************** INPUT DATA *****************

********* GENERAL AIRCRAFT DATA *********

Class E at 630,000 pounds Gross Weight

W= 630000.0 WM= 392.00 WRM= 3900.00 WN= 1750.00 A= 32.000 B= 915.500 MMI= 480000000.

SXM= 2.0 SXN= 1.0 SLM= 175.0 SLN= 170.0 PSARM= 1800.5 TAILRM= 1149.5C= 153.00

AAM= 35.00 AHM= 91.59 PAOM= 450.00 VOM= 2735.00 OAM= 3.45 TSM = 56660.00

AARM= 35.00 AHRM= 78.86 PAORM= 325.00 VORM= 2690.00 TSRM= 56650.00

AAN= 63.60 AHN= 51.30 PAON= 130.00 VON= 1600.00 OAN= 4.34 TSN = 28334.09

CL= .615 CD= .055 AREA= 5500.00 SPEED= 1.0 THRUST=168000. TAKOFF= 241.00

STROKE NOSE	PIN DIAMETER
0.000	2.060
.800	2.110
13.000	2.150
19.000	2.250
25.000	2.280

STROKE MAIN	PIN DIAMETER
0.000	1.470
2.000	1.280
4.000	1.410
13.000	1.630
18.000	1.840
21.000	1.930
24.000	1.930
26.500	2.000
31.000	2.000

STROK REAR MLG	PIN DIAMETER
0.000	1.560
5.500	1.410
9.000	1.750
13.000	1.970
16.000	2.000
21.00	2.030
25.50	2.120
31.00	2.12

TABLE X - Continued

MODE	SIPS	SINOSE	SIC.	SIMAIN	SIRMAIN	SITAIL	OMEGA	GEN. MASS
1	-.07	-.34	-.75	-.03	-.56	-.08	6.35	46.4
2	[illegible]	[illegible]	[illegible]	.02	0.38	-.02	10.85	81.4
3	[illegible]	.17	[illegible]	-.01	.01	.05	11.59	73.3
4	.75	.61	-.13	-.16	-.39	.01	14.63	735.7
[illegible]	.31	.23	-.13	-.14	-.14	.52	16.93	56.2
[illegible]	-.13	[illegible]	[illegible]	[illegible]	[illegible]	-.12	24.13	206.0
7	[illegible]	[illegible]	[illegible]	[illegible]	-.38	.16	26.20	52.2
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-.07	27.63	46.5
9	-.12	-.23	[illegible]	.15	-.13	-.13	34.70	77.2
1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-.02	[illegible]	41.73	14.9

********** INITIAL CONDITIONS ************

54323.0 316953.[illegible] 25892.[illegible] -2.8 -2.3 -1.9 -21.6 -21.0 -21.3 .0 -.0 .0

ZMI= -2.794 ZMI'= -2.284 ZMI= -1.917 THETAI= .00[illegible] ZCGI= -23.821

XMAIN= -21.321 XNOSE= -21.[illegible]2[illegible] REACTN= -54330. REACTM= -31[illegible]850. REACTRM= -258820.

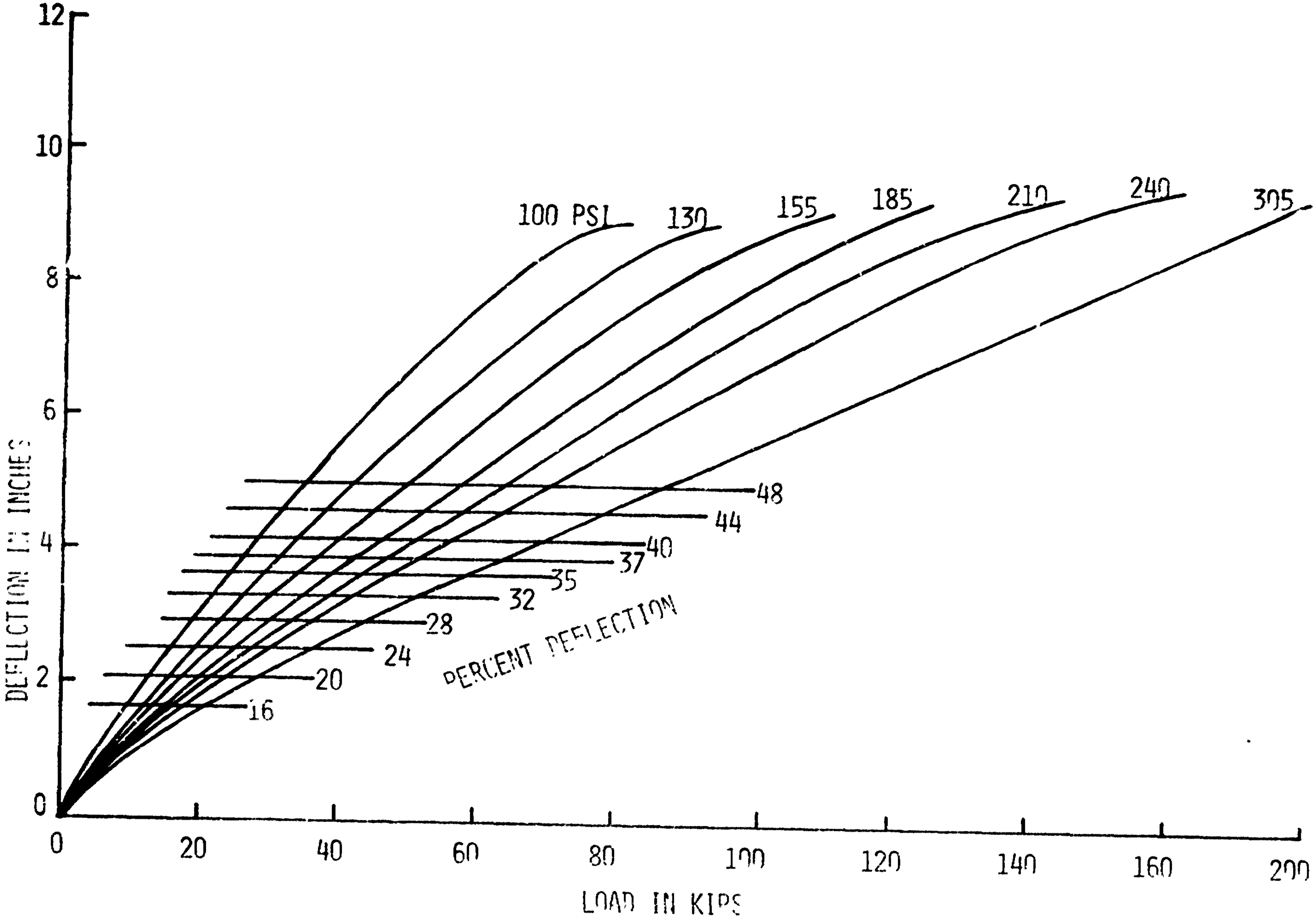


Figure 12 - Class E Aircraft Nose Landing Gear Tire Deflection Curves

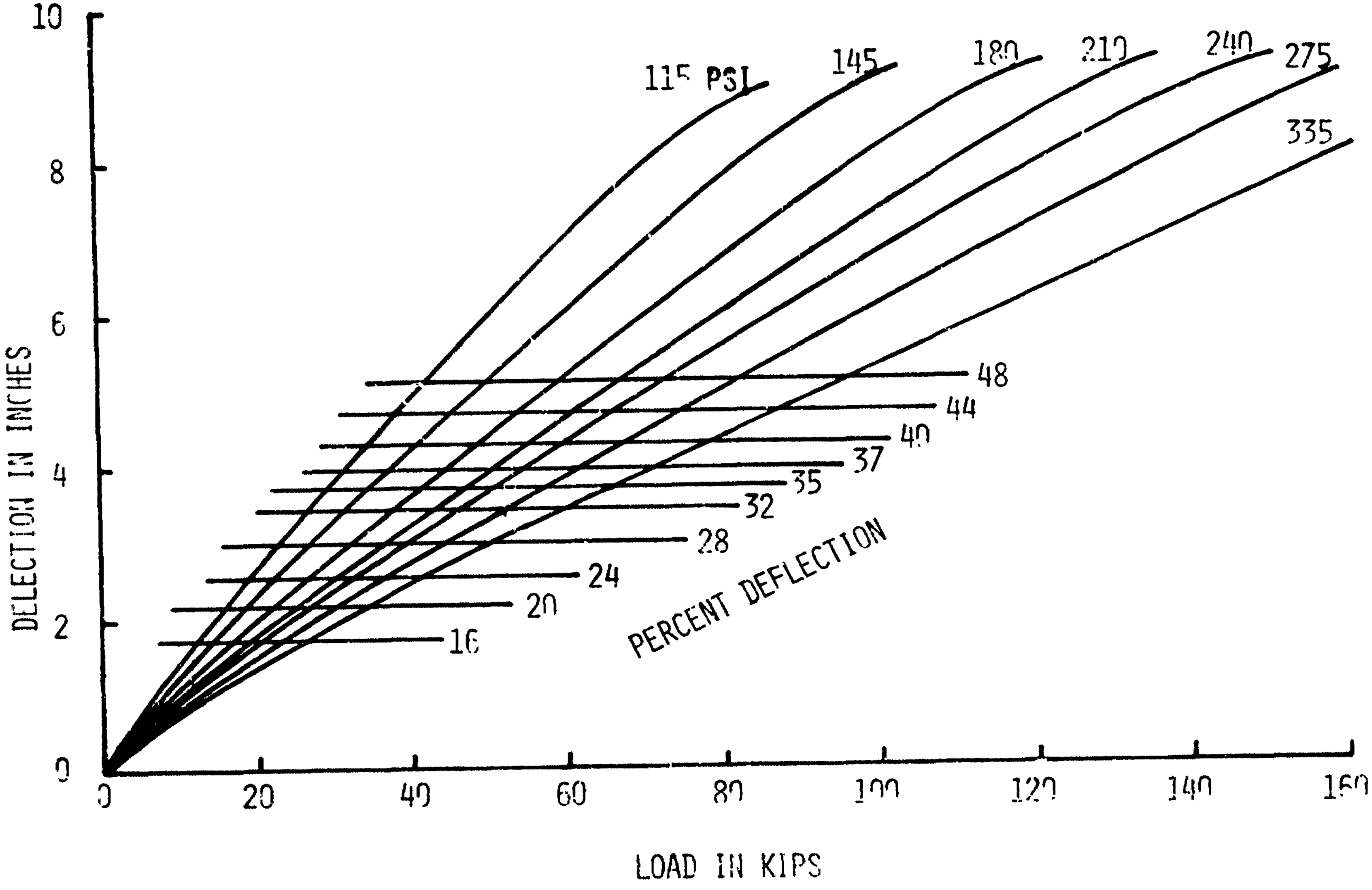


Figure 13 - Class E Aircraft Main Landing Gear Tire Deflection Curves

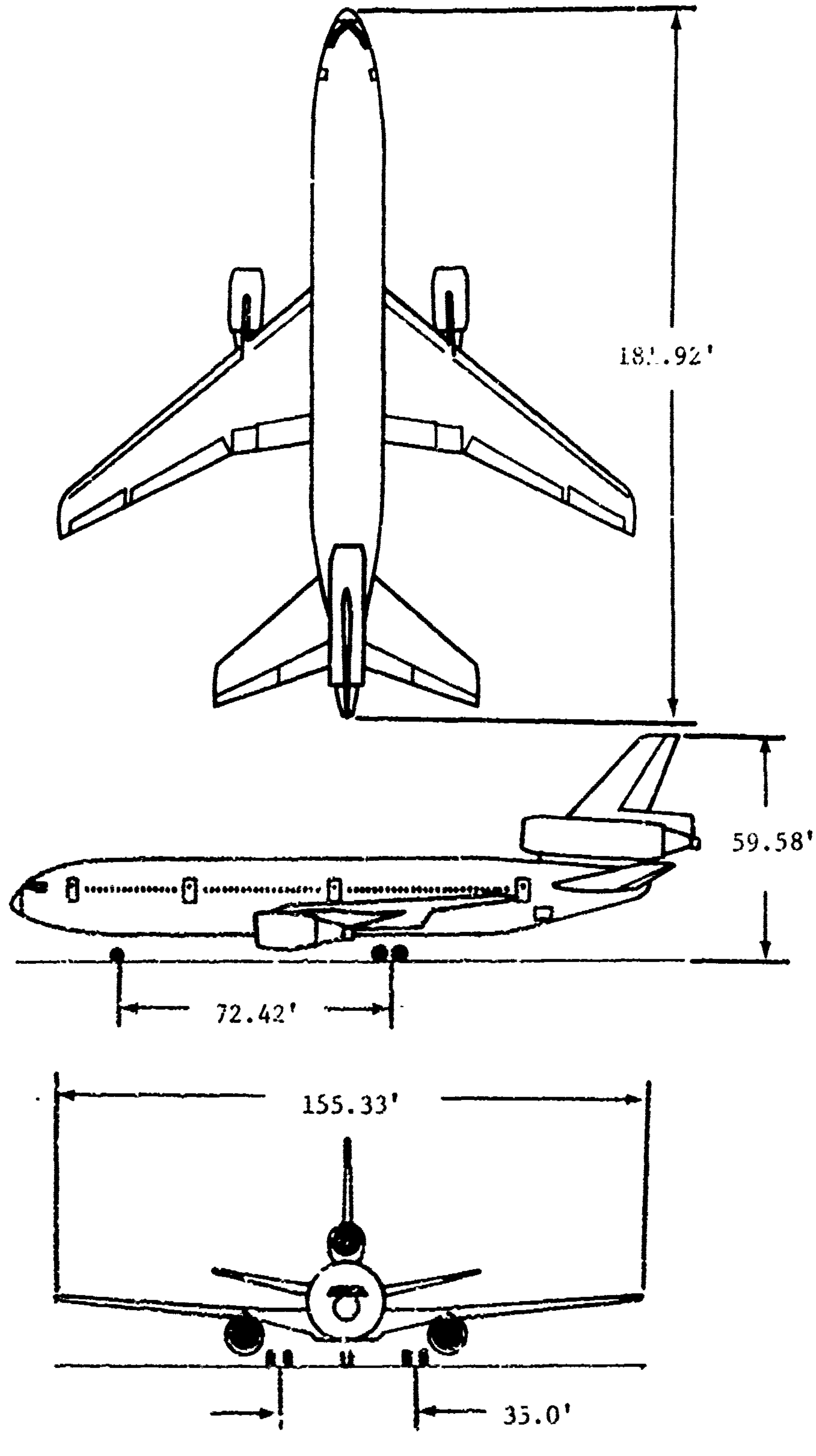


Figure 14 - Class D Aircraft General Configuration

TABLE XI - List of Input Data Fortran Names

```
*****************************************************  *****************TAXI0520
C          READ AND PRINT INPUT DATA                                    TAXI0530
************************************************************************TAXI0540
C   W=VEHICLE WEIGHT AT CG (POUNDS)                                     TAXI0550
C   A=DISTANCE MAIN GEAR TO CG (INCHES)                                 TAXI0560
C   B=DISTANCE NOSE GEAR TO CG (INCHES)                                 TAXI0570
C MMI=MASS MOMENT OF INERTIA (LB IN SEC SQ)                             TAXI0580
C  PLANE= AIRPLANE BEING SIMULATED AND  GROSS WEIGHT                    TAXI0590
C  PSARM = DISTANCE OF PILOT STATION TO CG                              TAXI0600
C      TAILRM = DISTANCE OF TAIL STATION TO CG                          TAXI0610
C  TAKOFF= TAKE-OFF SPEED (FEET/SEC)                                    TAXI0620
C SPEED =INITIAL  VEL  OF  AIRPLANE                                     TAXI0630
C  THRUST= TOTAL AIRPLANE THRUST                                        TAXI0640
C  CL=LIFT COEFF.                                                       TAXI0650
C  AREA=WING AREA                                                       TAXI0660
C  CD=DRAG COEFF.                                                       TAXI0670
C  WM=WEIGHT OF MAIN GEAR  (EACH)                                       TAXI0680
C  WN=WEIGHT OF NOSE GEAR                                               TAXI0690
C  SXM= NUMBER OF MAIN GEAR STRUTS                                      TAXI0700
C   SXN= NUMBER OF NOSE GEAR STRUTS                                     TAXI0710
C AHN  HYDRAULIC PISTON AREA NOSE SQ INCHES                             TAXI0720
C AAN  PNEUMATIC PISTON AREA NOSE SQ INCHES                             TAXI0730
C AHM  HYDRAULIC PISTON AREA MAIN SQ INCHES                             TAXI0740
C AAM  PNEUMATIC PISTON AREA MAIN SQ INCHES                             TAXI0750
C PAON NOSE STRUT PRELOAD PRESSURE  PSI                                 TAXI0760
C PAOM MAIN STRUT PRELOAD PRESSURE  PSI                                 TAXI0770
C VON  NOSE STRUT INITIAL VOLUME CU. IN.                                TAXI0780
C VOM  MAIN STRUT INITIAL VOLUME CU. IN.                                TAXI0790
C OAM  ORIFACE AREA MAIN                                                TAXI0800
C OAN  ORIFACE AREA NOSE                                                TAXI0810
C SLM=MAIN GEAR STRUT LENGTH UNLOADED INCHES                            TAXI0820
C      DISTANCE FROM CL OF AXLE TO CG LINE                              TAXI0830
C SLN=NOSE GEAR STRUT LENGTH UNLOADED INCHES                            TAXI0840
C      DISTANCE FROM CL OF AXLE TO CG LINE                              TAXI0850
C  TSM    MAIN TIRE SPRING CONSTANT PER STRUT                           TAXI0860
C  TSN    NOSE TIRE SPRING CONSTANT PER STRUT                           TAXI0870
C  DX=TIME STEP SIZE                                                    TAXI0880
C  IFPLOT   NO PLOT IF IFPLOT =1.                                       TAXI0890
C  IFLIST   NO LIST IF IFLIST =1.                                       TAXI0900
C  READ METERING PIN DESCRIPTION STARTING AT ZERO STROKE                TAXI0910
C  NSCN=# OF METERING PIN CHANGES NOSE GEAR                             TAXI0920
C  NSCM=# OF METERING PIN CHANGES MAIN GEAR                             TAXI0930
C  NFM = NUMBER OF FLEXIBLE MODES                                       TAXI0940
C  SIAXXX(I) = MODE SHAPE DEFLECTION (NON DIM.)                         TAXI0950
C  GM(I) = GENERALIZED MASS (POUNDS-SEC SQ/IN)                          TAXI0960
C  OMEGA (I) = MODAL FREQUENCIES (RAD/SEC)                              TAXI0970
```

TABLE XII · List of Data Used to Simulate Class D Aircraft

**************** INPUT DATA ****************

********* GENERAL AIRCRAFT DATA *********

Class D Aircraft 440000 pounds Gross Weight

W= 440000.0	WM= 5104.24	WN= 651.05	A= 73.000	B= 790.040	MMI= 211600000.
SXM= 2.0	SXN= 1.0	SLM= 150.0	SLN= 150.0	PSARM= 1015.0	TAILRM= 557.0
AAM= 103.05	AMM= 89.24	PAOM= 230.00	VOM= 2540.71	OAM= 2.50	TSM = 57600.00
AAN= 30.40	AMN= 31.74	PAON= 100.00	VON= 660.56	OAN= 1.24	TSN = 21040.00
CL= .460	CD= .080	AREA= 3647.00	SPEED= 1.0	THRUST=110000.	TAKOFF= 260.00

STROKE NOSE	PIN DIAMETER
0.000	.660
3.000	.850
9.000	1.020
15.000	1.130
17.000	1.140

STROKE MAIN	PIN DIAMETER
0.000	1.600
4.000	1.800
9.000	2.150
18.000	2.250
23.500	2.250

TABLE XII - Continued

MODE	SIPS	SINOSE	SIGG	SIMAIN	SITAIL	OMEGA	GEN. MASS
1	.31	-.01	-.34	-.33	-.10	7.52	26.1
2	.31	.01	.00	.01	-.38	12.62	77.2
3	.41	.25	-.38	-.13	.08	18.10	39.3
4	.08	.05	-.30	.07	.32	22.64	18.2
5	-.37	-.04	-.00	-.09	.06	22.98	17.0
6	.35	.02	-.35	-.04	-.36	24.22	39.9
7	-.31	-.31	-.32	-.03	-.06	24.75	7.9
8	-.25	-.11	.12	.14	-.04	27.98	32.8
9	-.20	-.38	.12	.04	.04	32.16	1124.3
10	.21	.07	-.33	-.37	.18	43.20	18.4

********** INTIAL CONDITIONS ************

ZMI= -3.499 ZVI= -1.688 THETAI= -.009016 ZCGI= -24.226

XMAIN= -21.385 XNOSE= -15.343 REACTM= -36875. REACTN= -487125.

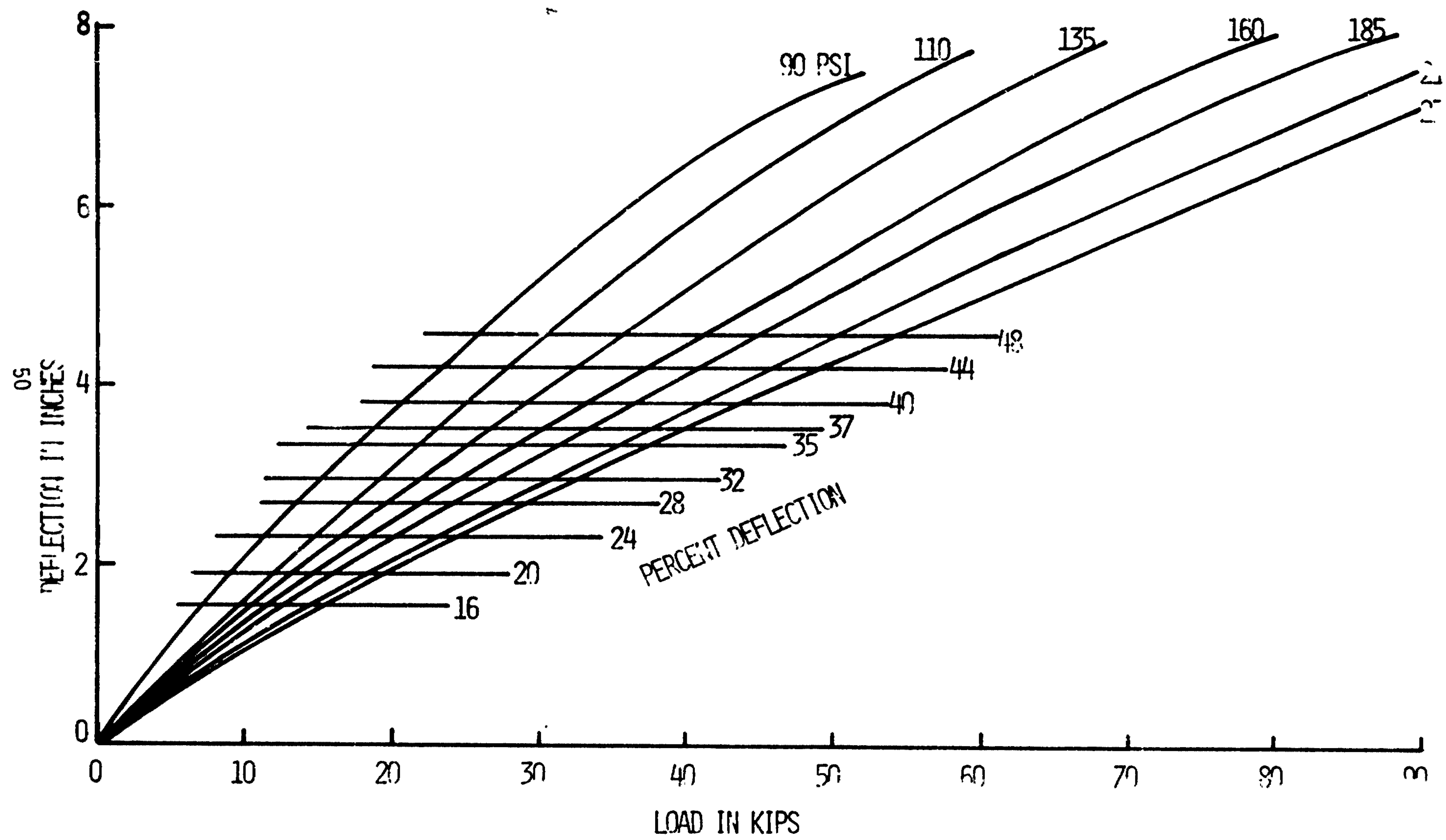


Figure 15 - Class D Aircraft Landing Gear Tire Deflection Curves

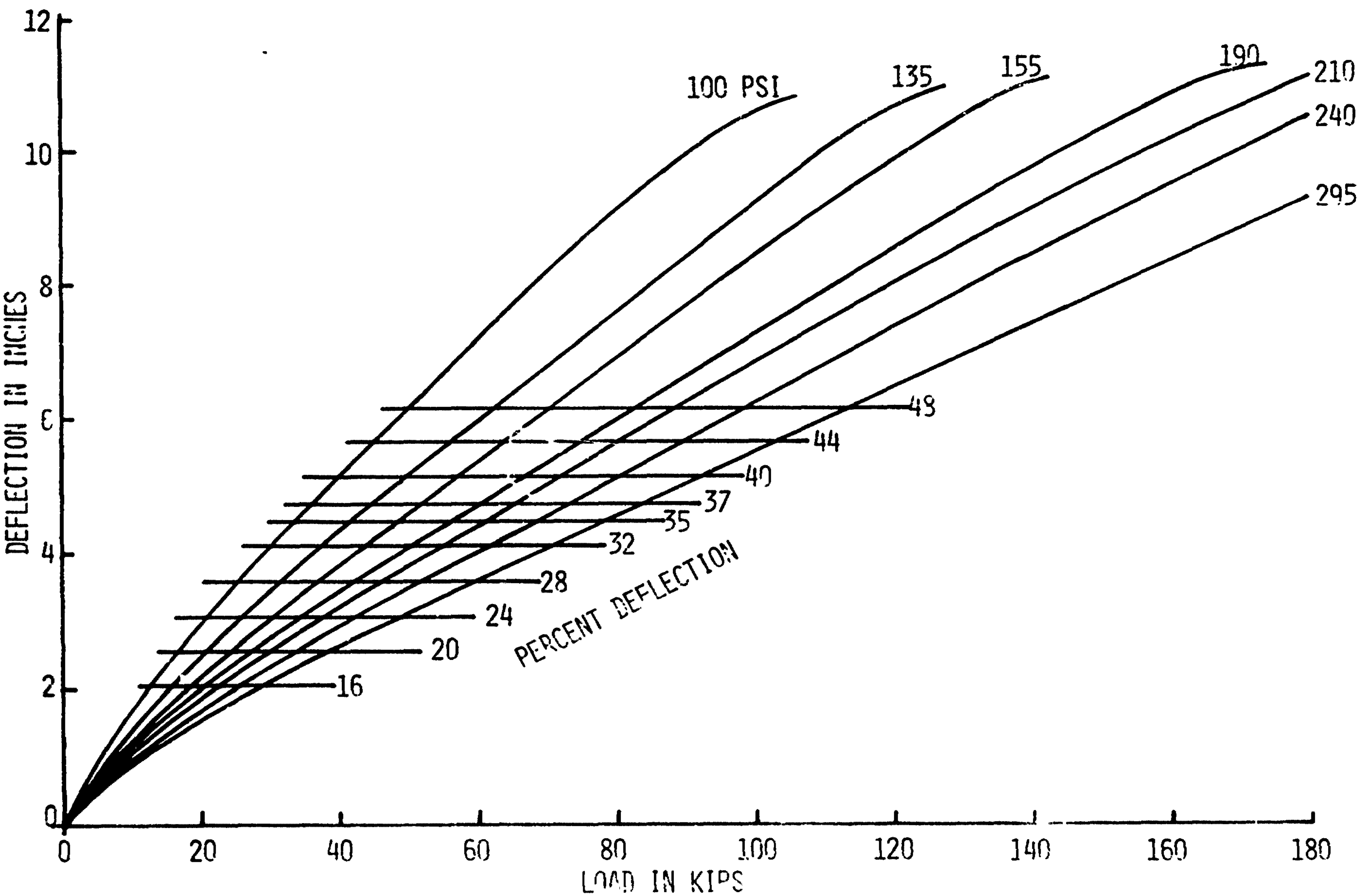


Figure 16 - Class D Aircraft Main Landing Gear Tire Deflection Curves

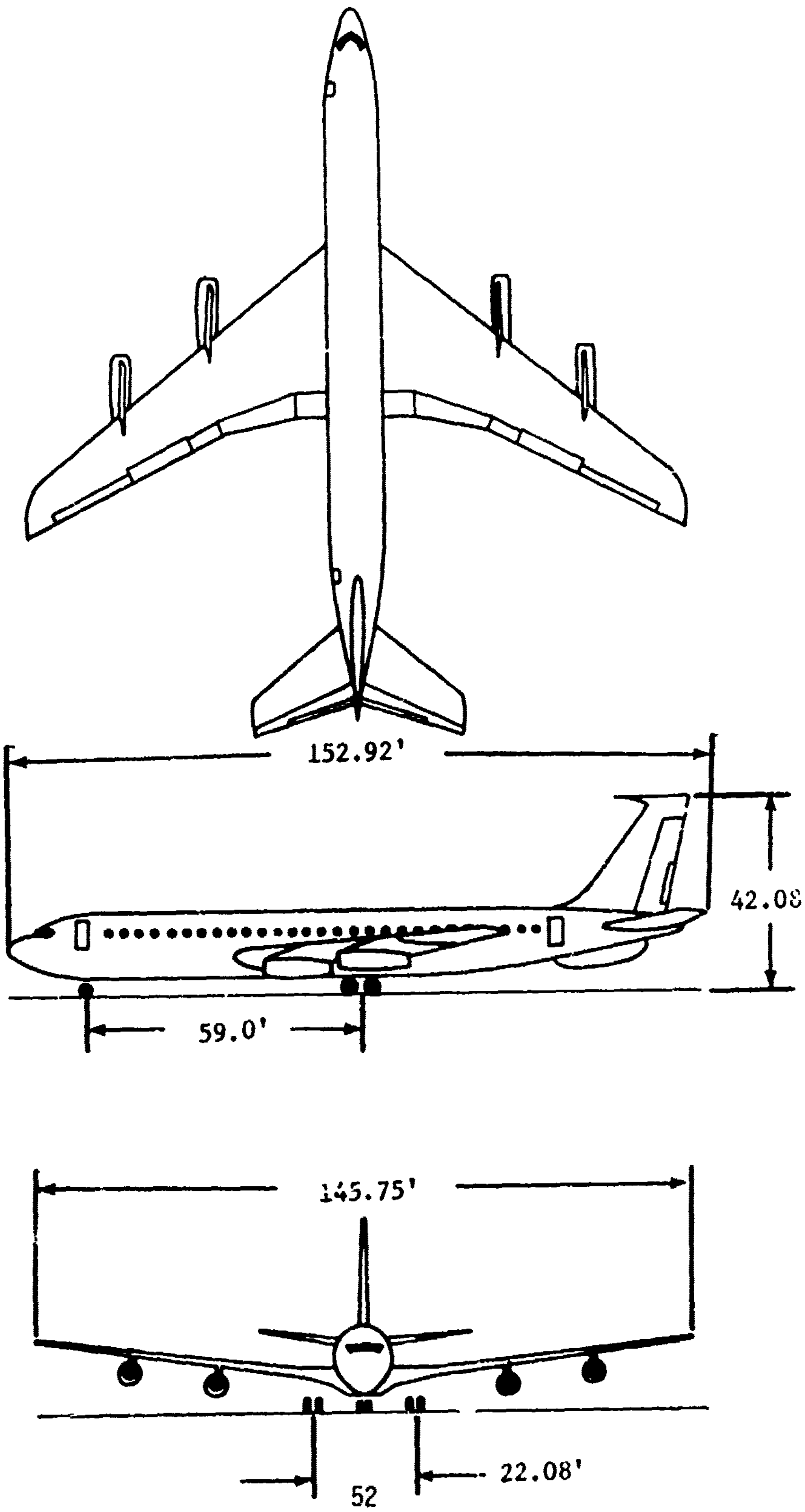


Figure 17. Class C Aircraft General Configuration

TABLE XIII - List of Input Data Fortran Names

```
**************************************************************TAXI0520
C        READ AND PRINT INPUT DATA                              TAXI0530
**************************************************************TAXI0540
C   W=VEHICLE WEIGHT AT CG (POUNDS)                             TAXI0550
C   A=DISTANCE MAIN GEAR TO CG (INCHES)                         TAXI0560
C   B=DISTANCE NOSE GEAR TO CG (INCHES)                         TAXI0570
C MYI=MASS MOMENT OF INERTIA (LB IN SEC SQ)                     TAXI0580
C  PLANE= AIRPLANE BEING SIMULATED AND  GROSS WEIGHT            TAXI0590
C  PSAFM = DISTANCE OF PILOT STATION TO CG                      TAXI0600
C     TAILRM = DISTANCE OF TAIL STATION TO CG                   TAXI0610
C  TAKOFF= TAKE-OFF SPEED (FEET/SEC)                            TAXI0620
C SPEED =INITIAL  VEL  OF  AIRPLANE                             TAXI0630
C  THRUST= TOTAL AIRPLANE THRUST                                TAXI0640
C  CL=LIFT COEFF.                                               TAXI0650
C  AREA=WING AREA                                               TAXI0660
C  CD=DRAG COEFF.                                               TAXI0670
C  WM=WEIGHT OF MAIN GEAR  (EACH)                               TAXI0680
C  WN=WEIGHT OF NOSE GEAR                                       TAXI0690
C  SAM= NUMBER OF MAIN GEAR STRUTS                              TAXI0700
C   SAN= NUMBER OF NOSE GEAR STRUTS                             TAXI0710
C AHN  HYDRAULIC PISTON AREA NOSE SQ INCHES                     TAXI0720
C AAN  PNEUMATIC PISTON AREA NOSE SQ INCHES                     TAXI0730
C AHM  HYDRAULIC PISTON AREA MAIN SQ INCHES                     TAXI0740
C AAM  PNEUMATIC PISTON AREA MAIN SQ INCHES                     TAXI0750
C PAON NOSE STRUT PRELOAD PRESSURE  PSI                         TAXI0760
C PAOM MAIN STRUT PRELOAD PRESSURE  PSI                         TAXI0770
C VON  NOSE STRUT INITIAL VOLUME CU. IN.                        TAXI0780
C VOM  MAIN STRUT INITIAL VOLUME CU. IN.                        TAXI0790
C DAM  ORIFACE AREA MAIN                                        TAXI0800
C DAN  ORIFACE AREA NOSE                                        TAXI0810
C SLM=MAIN GEAR STRUT LENGTH UNLOADED INCHES                    TAXI0820
C      DISTANCE FROM CL OF AXLE TO CG LINE                      TAXI0830
C SLN=NOSE GEAR STRUT LENGTH UNLOADED INCHES                    TAXI0840
C      DISTANCE FROM CL OF AXLE TO CG LINE                      TAXI0850
C  TSM    MAIN TIRE SPRING CONSTANT PER STRUT                   TAXI0860
C  TSN    NOSE TIRE SPRING CONSTANT PER STRUT                   TAXI0870
C  D =TIME STEP SIZE                                            TAXI0880
C  IFPLOT   NO PLOT IF IFPLOT =1.                               TAXI0890
C  IFLIST   NO LIST IF IFLIST =1.                               TAXI0900
C  READ METERING PIN DESCRIPTION STARTING AT ZERO STROKE        TAXI0910
C  NSCN=# OF METERING PIN CHANGES NOSE GEAR                     TAXI0920
C  NSCM=# OF METERING PIN CHANGES MAIN GEAR                     TAXI0930
C  NFM = NUMBER OF FLEXIBLE MODES                               TAXI0940
C  SIXXXX(I) = MODE SHAPE DEFLECTION (NON DIM.)                 TAXI0950
C  GM(I) = GENERALIZED MASS (POUNDS-SEC SQ/IN)                  TAXI0960
C  OMEGA (I) = MODAL FREQUENCIES (RAD/SEC)                      TAXI0970
```

TABLE XIV - List of Data Used to Simulate Class C Aircraft

****************** INPUT DATA ******************

********* GENERAL AIRCRAFT DATA *********

Class C 306000 pounds Gross Weight

W=	306000.0	WM=	1659.0	WN=	432.00	A=	30.000	B=	678.300	MMI=	8.730000.
SXM=	2.0	SXN=	1.0	SLM=	91.0	SLN=	91.0	PSARM=	757.0	TAILRM=	637.0
AAM=	75.47	AHM=	56.69	PAOM=	243.00	VOM=	1816.68	OAM=	3.14	TSM =	25050.0
AAN=	19.64	AHN=	13.91	PAON=	265.00	VON=	335.93	OAN=	1.23	TSN =	13000.00
CL=	.683	CD=	.013	AREA=	2890.00	SPEED=	1.0	THRUST=	48000.	TAKOFF=	299.00

STROKE NOSE	PIN DIAMETER
0.000	1.160
1.683	1.130
4.193	1.130
11.650	1.170
13.150	1.170
15.460	1.245
50.000	1.245

STROKE MAIN	PIN DIAMETER
0.000	1.567
3.750	1.567
6.750	1.517
7.750	1.517
9.800	1.567
10.650	1.583
11.580	1.580
21.750	1.979
50.809	1.979

TABLE XIV - Continued

MODE	SIPS	SINOSE	SICG	SIMAIN	SITAIL	OMEGA	GEN. MASS
1	-.02	-.03	-.09	-.10	-.21	6.22	29.5
2	.18	.15	.03	.33	.02	12.76	42.5
3	.09	.07	.01	.81	.05	14.62	113.3
4	.55	.45	-.03	-.02	.45	15.79	131.7
5	.54	.46	-.11	-.10	.36	17.91	47.3
6	-.87	-.06	-.03	-.83	.07	20.58	43.1
7	-.29	-.20	.15	.13	-.15	23.69	27.0
8	-.09	-.05	.01	.00	-.05		2.3
9	.16	.09	-.09	-.37	.07	41.15	43.1
10	.09	.05	-.05	-.15	.05	41.90	19.6

********* INTIAL CONDITIONS ************

ZMI= -5.849 ZNI= -.997 THETAI= -.021125 ZCGI= -25.318
XMAIN= -20.133 XNOSE= -9.399 REACTM= -12966. REACTM= -293034.

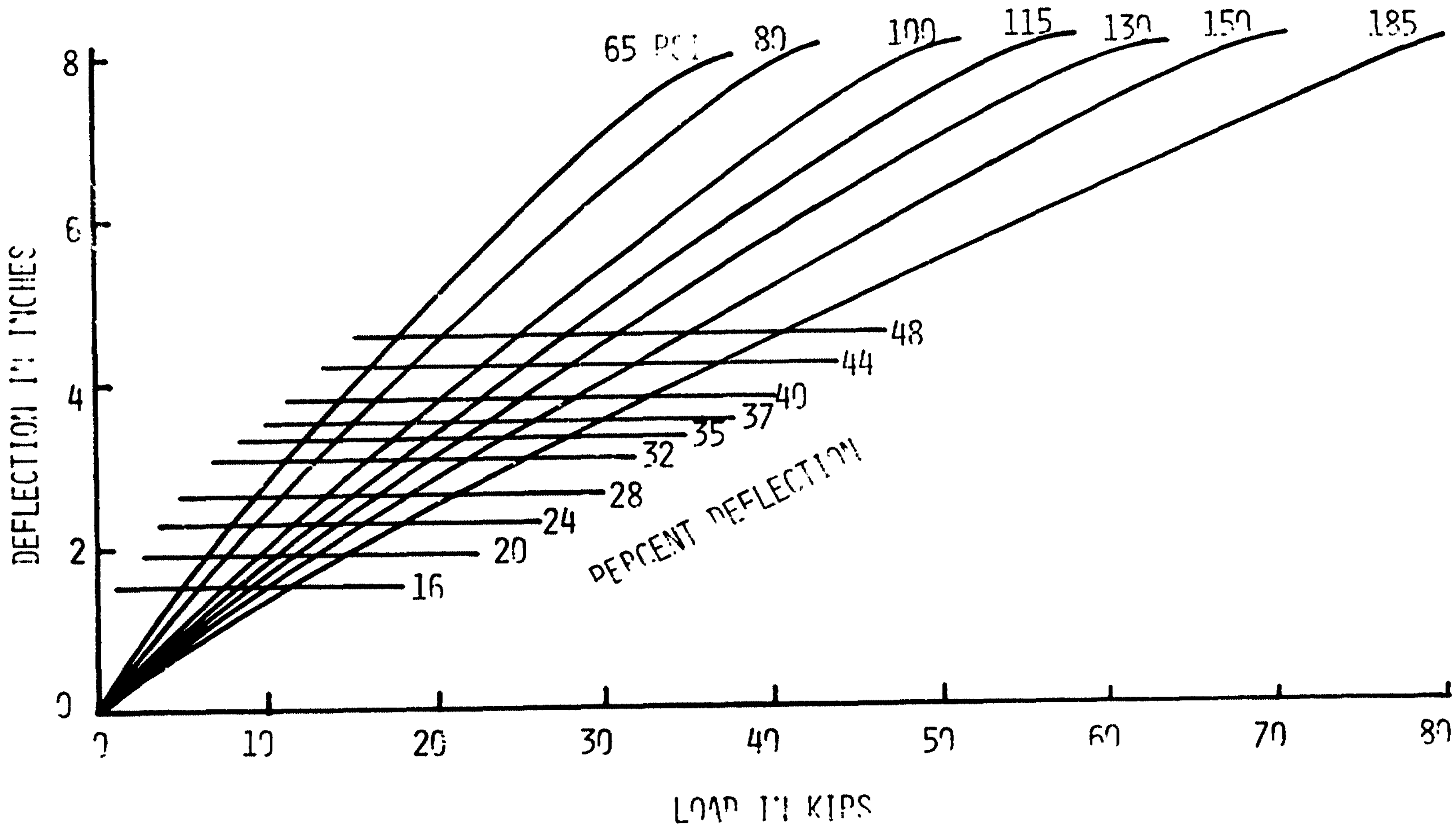


Figure 18. Class C Aircraft Nose Landing Gear Tire Deflection Curves

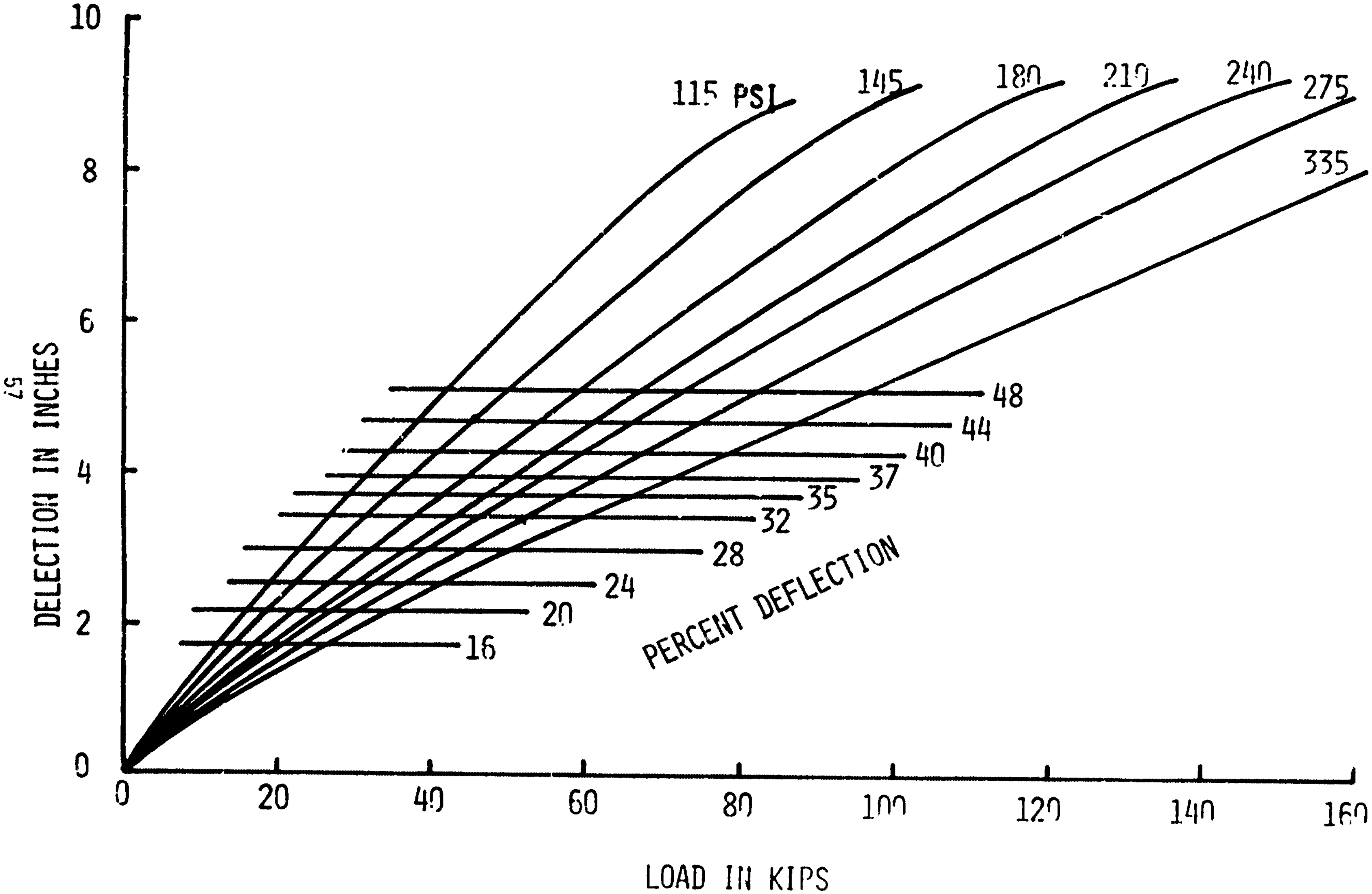


Figure 19. Class C Aircraft Main Landing Gear Tire Deflection Curves

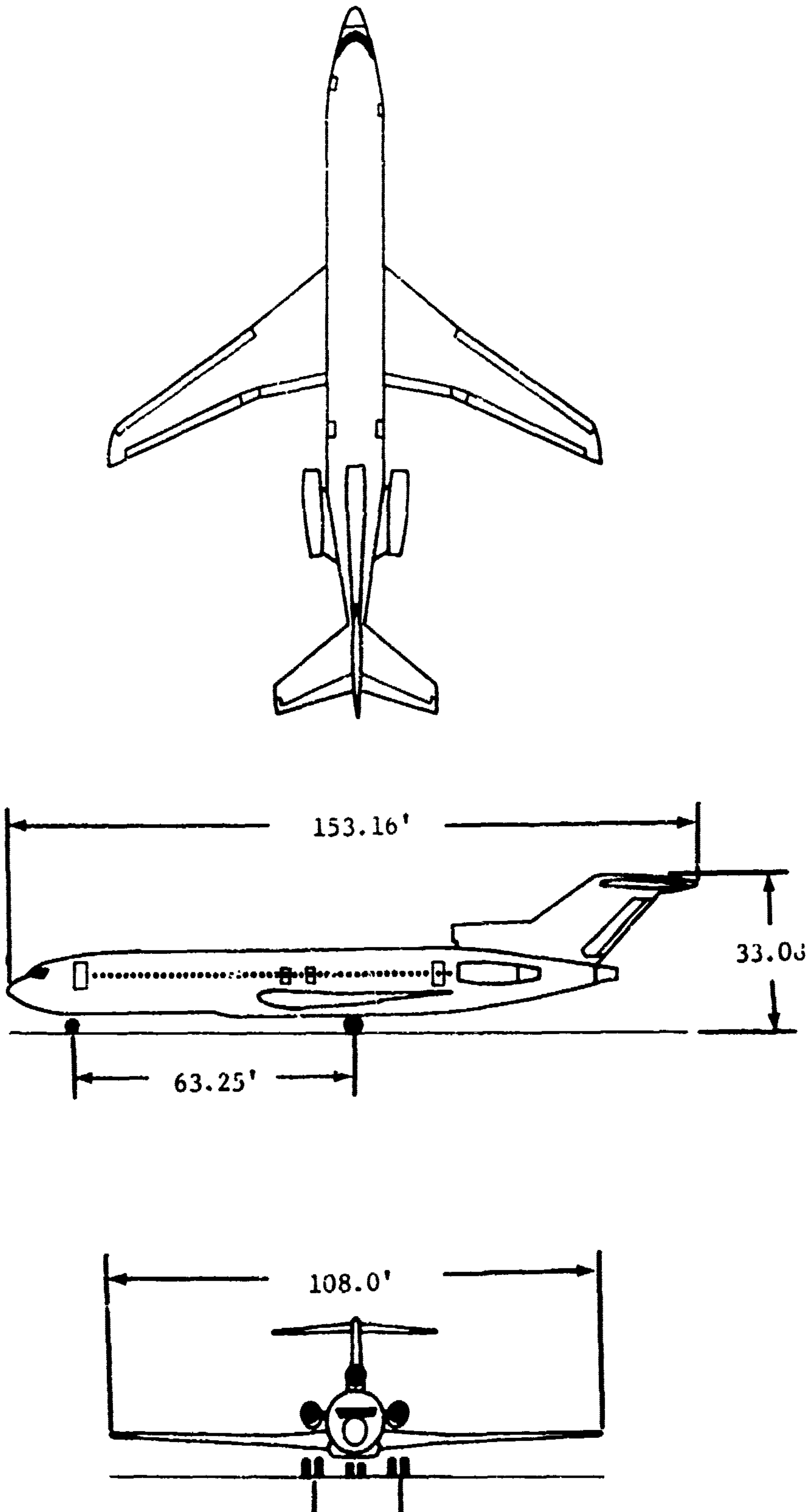


Figure 20. Class B Aircraft General Configuration

TABLE XV - List of Input Data Fortran Names

```
*****************************************************************TAXI0520
C        READ AND PRINT INPUT DATA                               TAXI0530
*****************************************************************TAXI0540
C    W=VEHICLE WEIGHT AT CG (POUNDS)                             TAXI0550
C    A=DISTANCE MAIN GEAR TO CG (INCHES)                         TAXI0560
C    B=DISTANCE NOSE GEAR TO CG (INCHES)                         TAXI0570
C YMI=MASS MOMENT OF INERTIA (LB IN SEC SQ)                      TAXI0580
C  PLANE= AIRPLANE BEING SIMULATED AND  GROSS WEIGHT             TAXI0590
C  FSAPM = DISTANCE OF PILOT STATION TO CG                       TAXI0600
C      TAILRM = DISTANCE OF TAIL STATION TO CG                   TAXI0610
C  TAKOFF= TAKE-OFF SPEED (FEET/SEC)                             TAXI0620
C SPEED =INITIAL  VEL  OF   AIRPLANE                             TAXI0630
C  THURST= TOTAL AIRPLANE THRUST                                 TAXI0640
C  CL=LIFT COEFF.                                                TAXI0650
C  AR=AR=WING AREA                                               TAXI0660
C  CD=DRAG COEFF.                                                TAXI0670
C  WM=WEIGHT OF MAIN GEAR   (EACH)                               TAXI0680
C  WN=WEIGHT OF NOSE GEAR                                        TAXI0690
C  SXM= NUMBER OF MAIN GEAR STRUTS                               TAXI0700
C   SXN= NUMBER OF NOSE GEAR STRUTS                              TAXI0710
C AHN  HYDRAULIC PISTON AREA NOSE SQ INCHES                      TAXI0720
C AAN  PNEUMATIC PISTON AREA NOSE SQ INCHES                      TAXI0730
C AHM  HYDRAULIC PISTON AREA MAIN SQ INCHES                      TAXI0740
C AAM  PNEUMATIC PISTON AREA MAIN SQ INCHES                      TAXI0750
C PAON NOSE STRUT PRELOAD PRESSURE  PSI                          TAXI0760
C PAOM MAIN STRUT PRELOAD PRESSURE  PSI                          TAXI0770
C VON  NOSE STRUT INITIAL VOLUME CU. IN.                         TAXI0780
C VOM  MAIN STRUT INITIAL VOLUME CU. IN.                         TAXI0790
C OAM  ORIFACE AREA MAIN                                         TAXI0800
C OAN  ORIFACE AREA NOSE                                         TAXI0810
C SLM=MAIN GEAR STRUT LENGTH UNLOADED INCHES                     TAXI0820
C      DISTANCE FROM CL OF AXLE TO CG LINE                       TAXI0830
C SLN=NOSE GEAR STRUT LENGTH UNLOADED INCHES                     TAXI0840
C      DISTANCE FROM CL OF AXLE TO CG LINE                       TAXI0850
C  TSM     MAIN TIRE SPRING CONSTANT PER STRUT                   TAXI0860
C  TSN     NOSE TIRE SPRING CONSTANT PER STRUT                   TAXI0870
C  DX=TIME STEP SIZE                                             TAXI0880
C  IFPLOT   NO PLOT IF IFPLOT =1.                                TAXI0890
C  IFLIST   NO LIST IF IFLIST =1.                                TAXI0900
C  READ METERING PIN DESCRIPTION STARTING AT ZERO STROKE         TAXI0910
C  NSCN=# OF METERING PIN CHANGES NOSE GEAR                      TAXI0920
C  NSCM=# OF METERING PIN CHANGES MAIN GEAR                      TAXI0930
C  NFM = NUMBER OF FLEXIBLE MODES                                TAXI0940
C  SIXXXX(I) = MODE SHAPE DEFLECTION (NON DIM.)                  TAXI0950
C  GM(I) = GENERALIZED MASS (POUNDS-SEC SQ/IN)                   TAXI0960
C  OMEGA (I) = MODAL FREQUENCIES (RAD/SEC)                       TAXI0970
```

TABLE XVI - List of Data Used to Simulate Class B Aircraft

****************** INPUT DATA ******************

********** GENERAL AIRCRAFT DATA **********

Class B   160000 pounds Gross Weight

W=	160000.0	WN=	1363.00	WM=	495.00	A=	30.700	B=	717.500	MMI=	62800000.
SXN=	2.0	SXM=	1.0	SLM=	112.0	SLN=	104.0	PSARM=	833.9	TAILRM=	336.?
AAM=	50.20	AHM=	40.30	PAOM=	285.00	VOM=	782.00	OAM=	1.77	TSM =	287?0.00
AAN=	19.00	AHN=	14.19	PAON=	110.00	VON=	229.90	OAN=	.95	TSN =	8594.00
CL=	.913	CD=	.085	AREA=	1560.00	SPEED=	1.0	THRUST=	39000.	TAKOFF=	252.00

STROKE NOSE	PIN DIAMETER
0.000	.976
7.450	.976
10.970	1.040
11.020	1.040
11.920	1.060
12.020	1.390

STROKE MAIN	PIN DIAMETER
0.000	1.050
7.000	1.050
10.000	1.300
12.750	1.390
14.000	1.490

TABLE XVI - Continued

MODE	SIPS	SINOSE	SICG	JIMAIN	SITAIL	OMEGA	GEN. MASS
1	-1.23	-.09	.01	.91	-.03	15.21	8.0
2	.22	.15	-.09	-.09	-.06	16.72	8.6
3	-.21	-.13	.06	.95	-.07	20.21	4.9
4	.42	.21	-.01	.31	.05	44.92	16.1
5	.12	.06	-.01	-.00	.01	46.75	6.0
6	-.02	-.01	.05	.35	.06	47.75	5.7
7	-.14	-.36	-.06	-.07	.02	59.80	4.9
8	-.34	-.01	.01	-.01	-.16	72.45	10.5
9	.65	.15	-.06	-.07	-.04	87.96	398.7
10	.26	.05	-.01	-.02	-.01	94.31	20.0

********* INTIAL CONDITIONS ************

ZMI= -3.660 ZNI= -.953 THETAI= -.007202 ZCGI= -14.694

XMAIN= -11.313 XNOSE= -0.574 REACTN= -8100. REACTM= -151012.

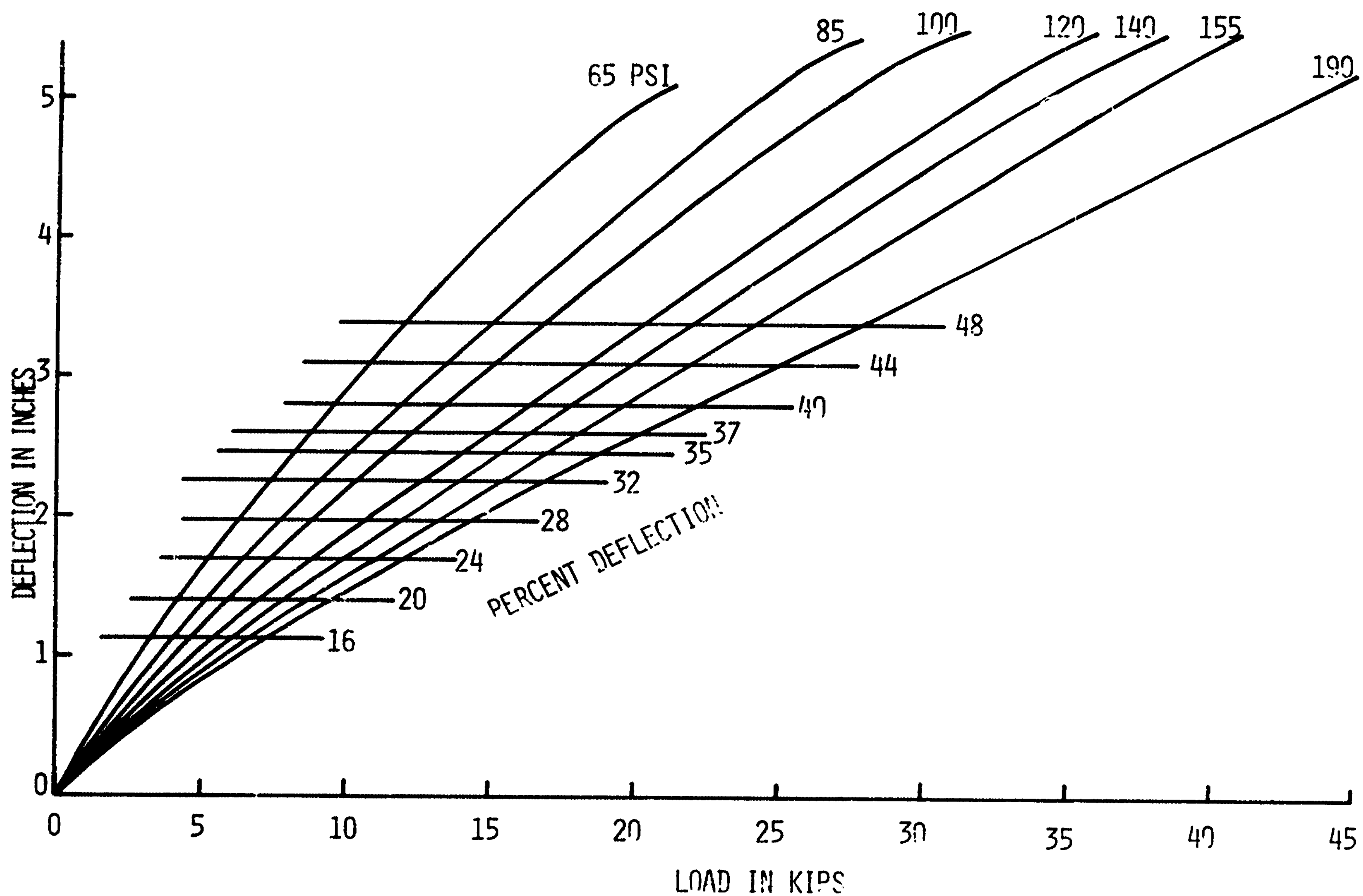


Figure 21. Class B Aircraft Nose Landing Gear Tire Deflection Curves

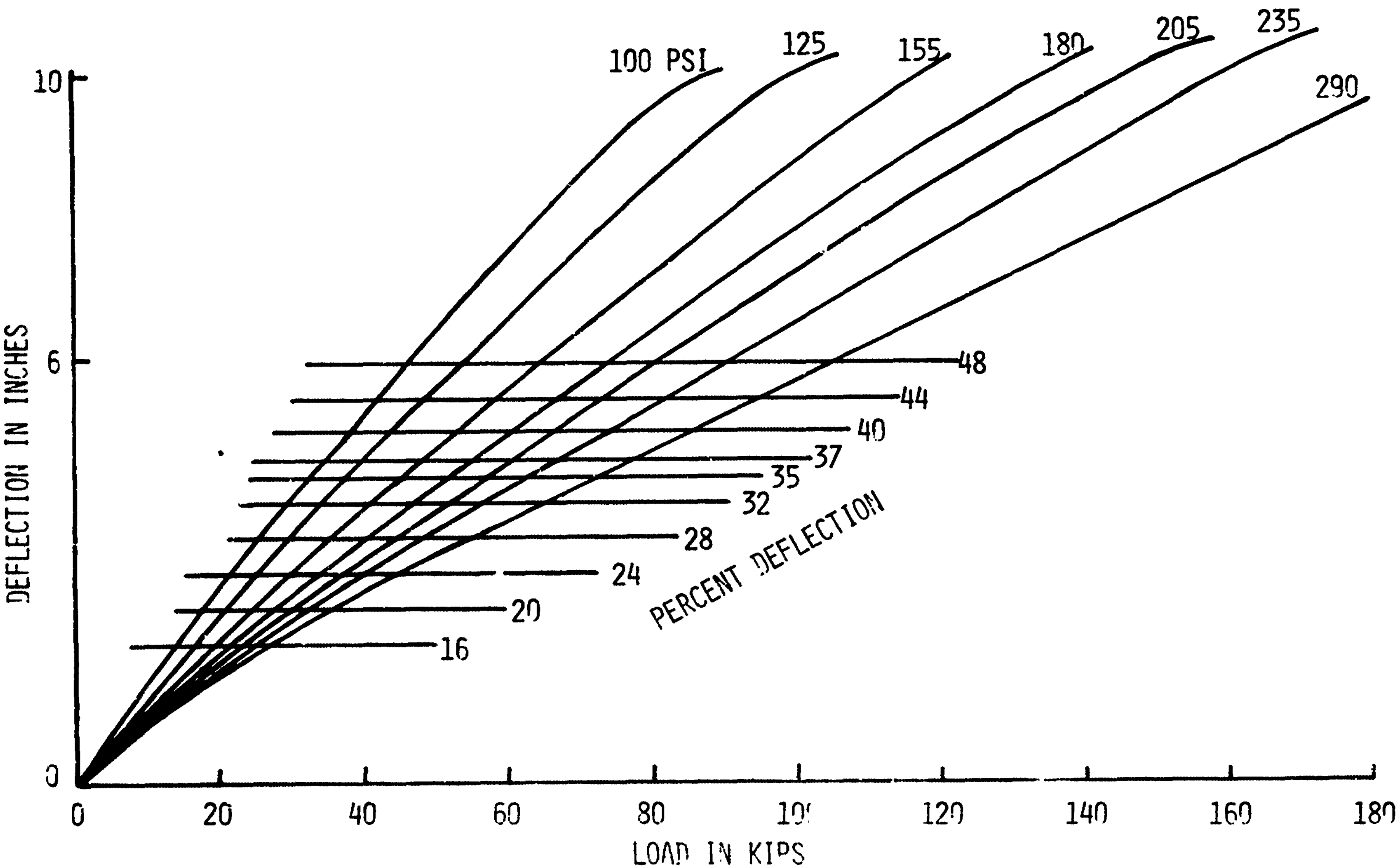


Figure 22. Class B Aircraft Main Landing Gear Tire Deflection Curves

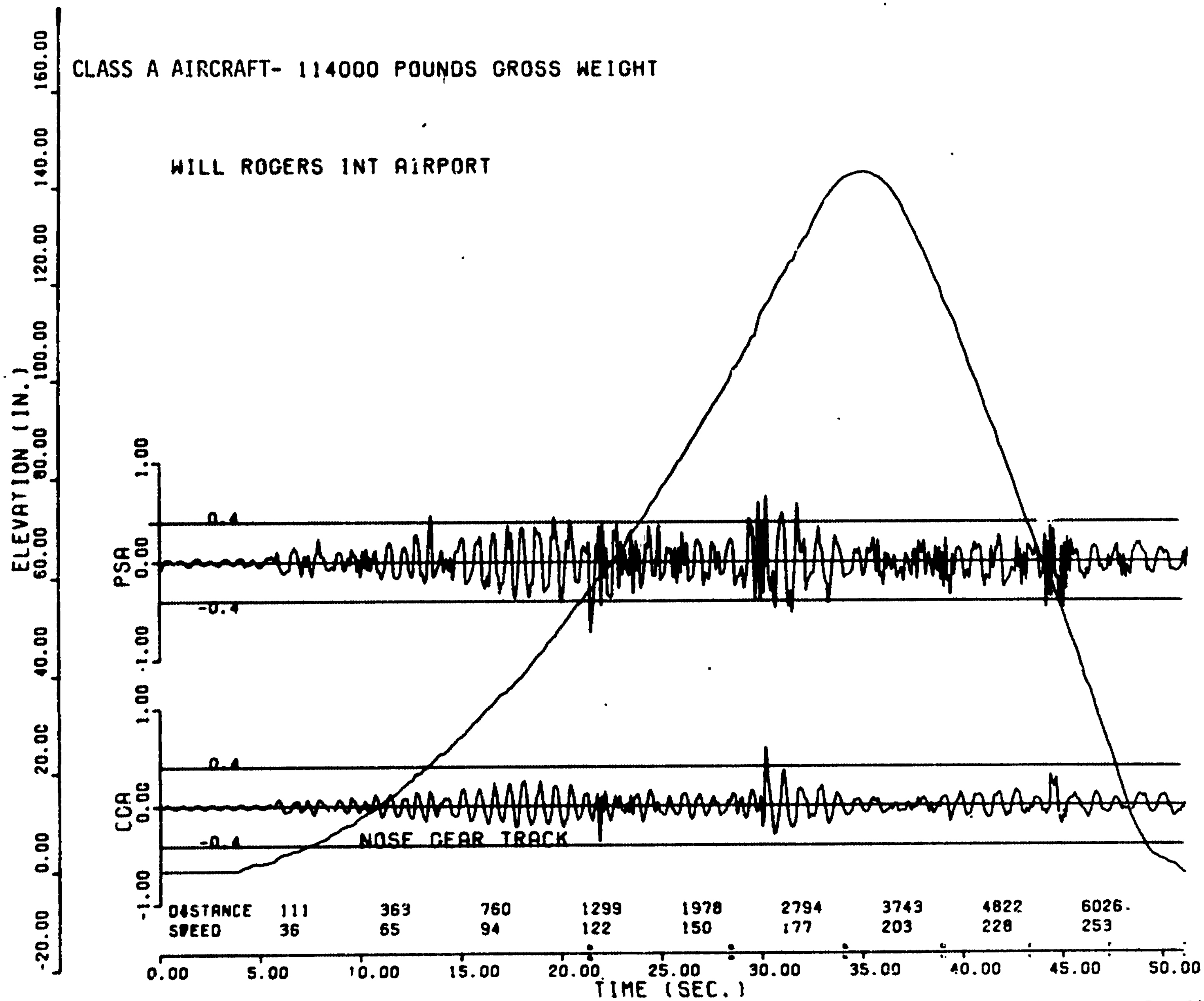


Figure 23. Plotted Results of Class A Aircraft Taking Off from the Will Rogers Profile

CLASS A AIRCRAFT 114000 POUNDS GROSS WEIGHT

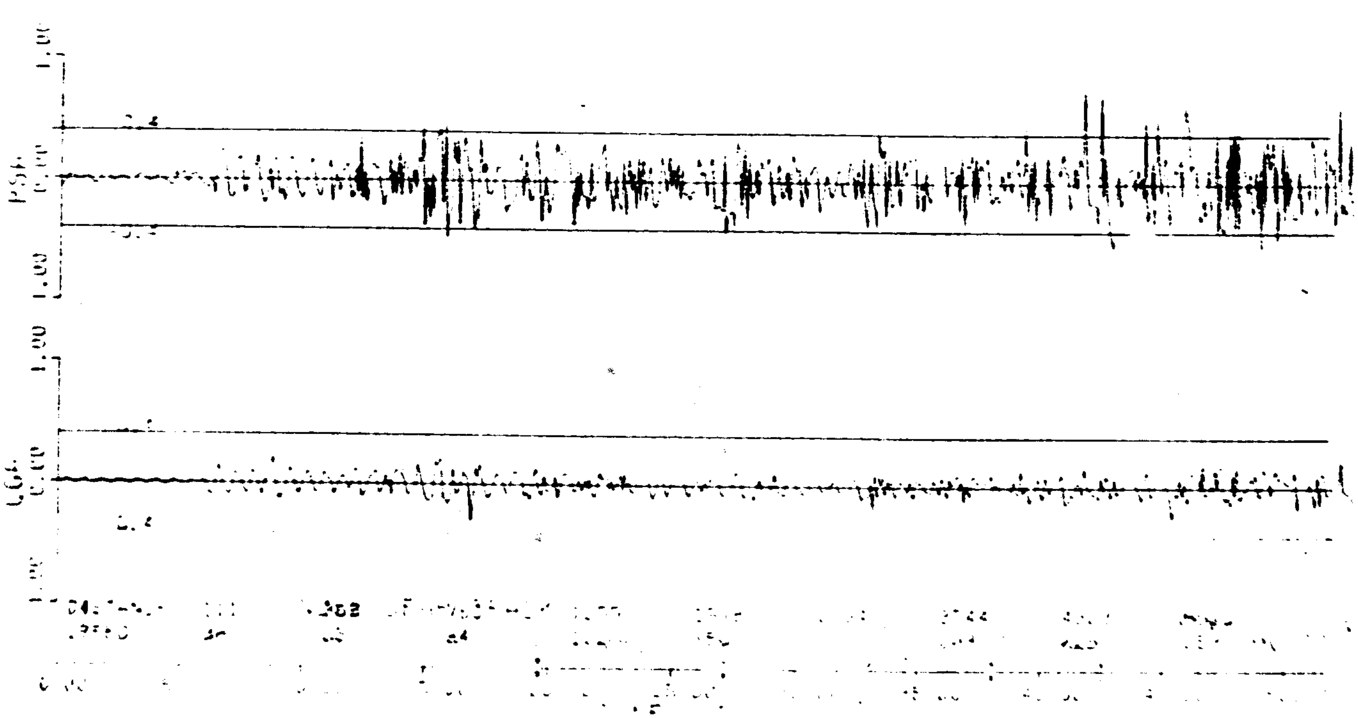


Figure 24. Plotted Results of Class A Aircraft Taking Off from the Dulles Profile

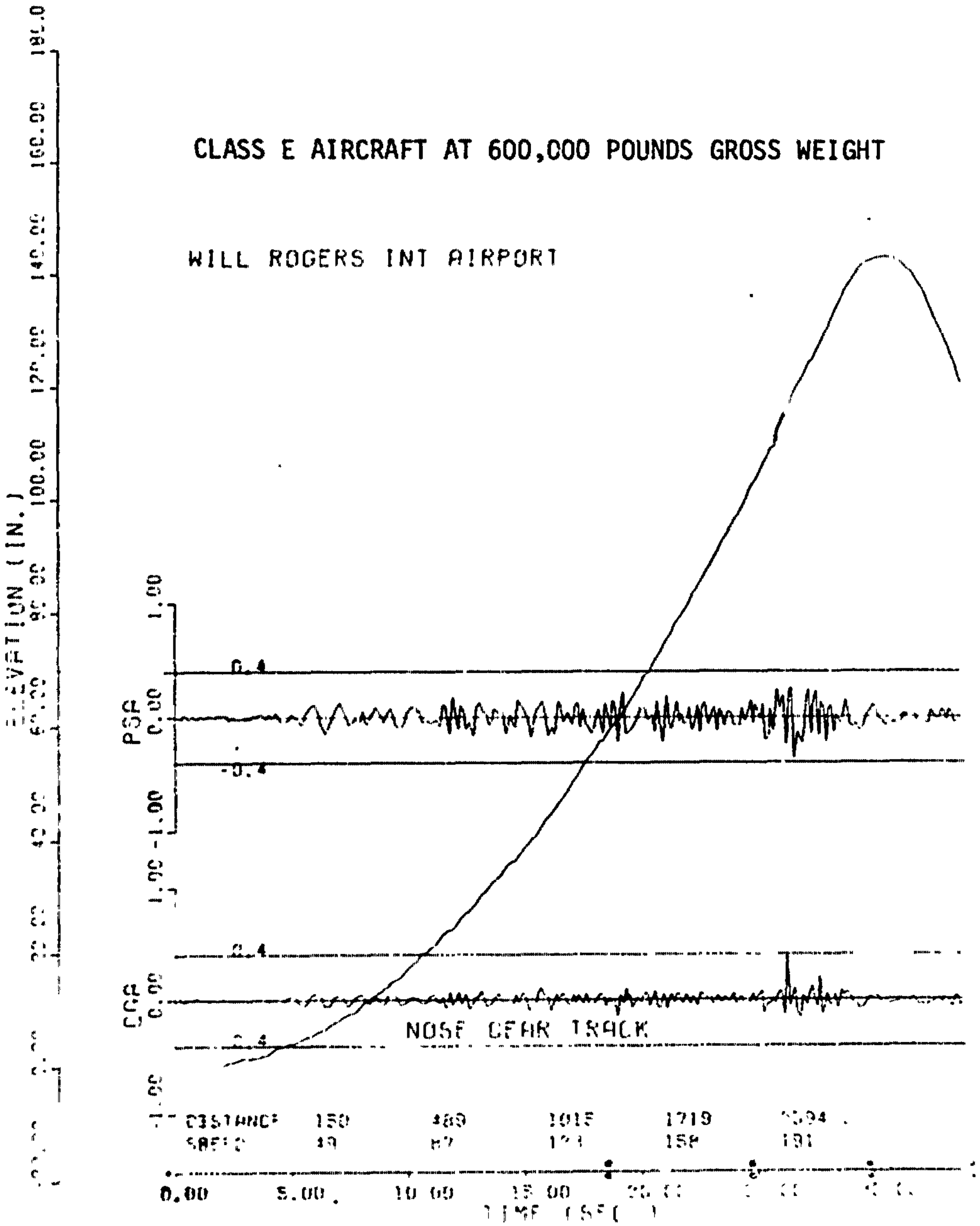


Figure 25. Plotted Results of Class E Aircraft Taking Off from the Will Rogers Profile

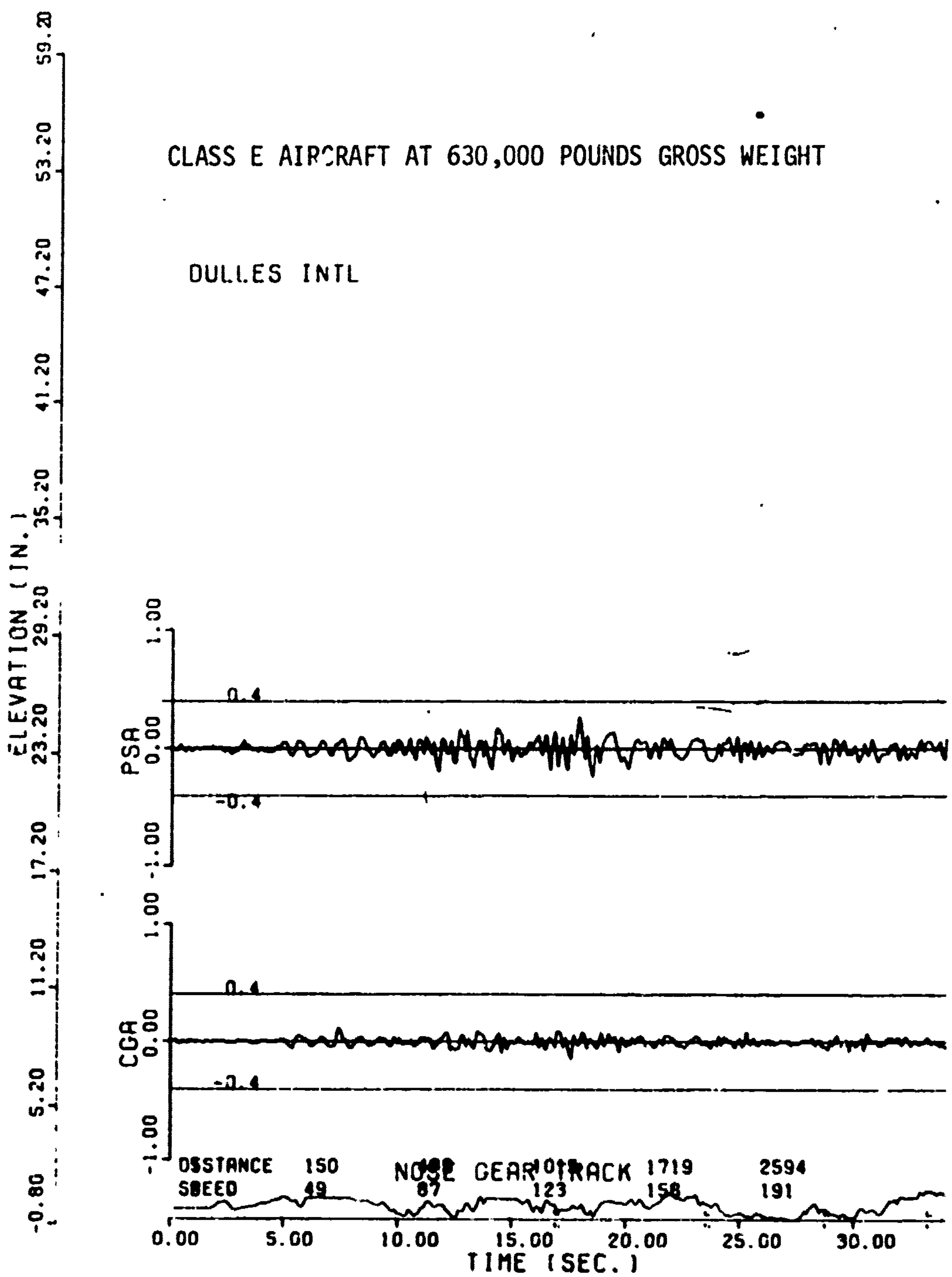


Figure 26. Plotted Results of Class E Aircraft Taking Off from the Dulles Profile

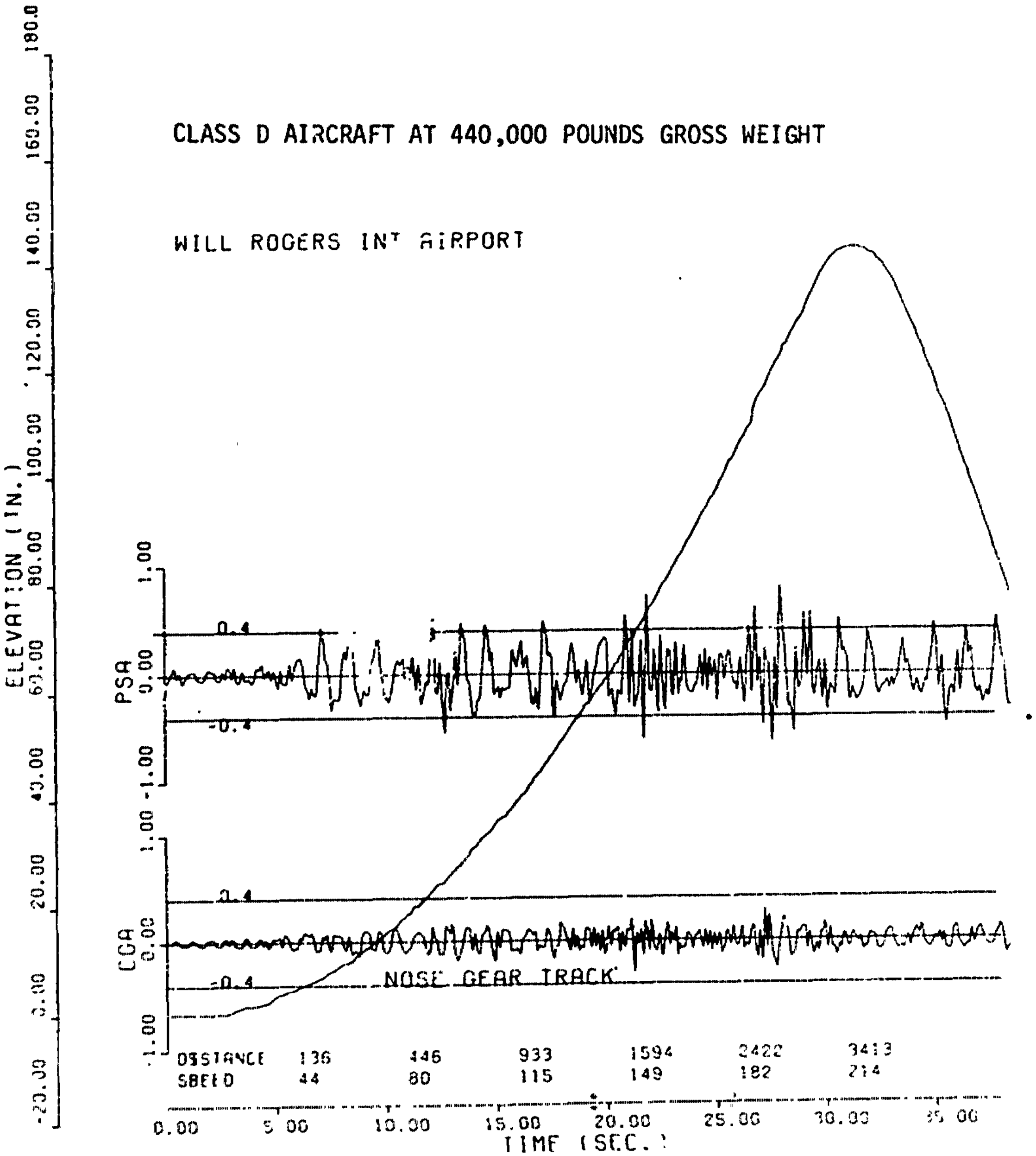


Figure 27. Plotted Results of Class D Aircraft Taking Off from the Will Rogers Profile

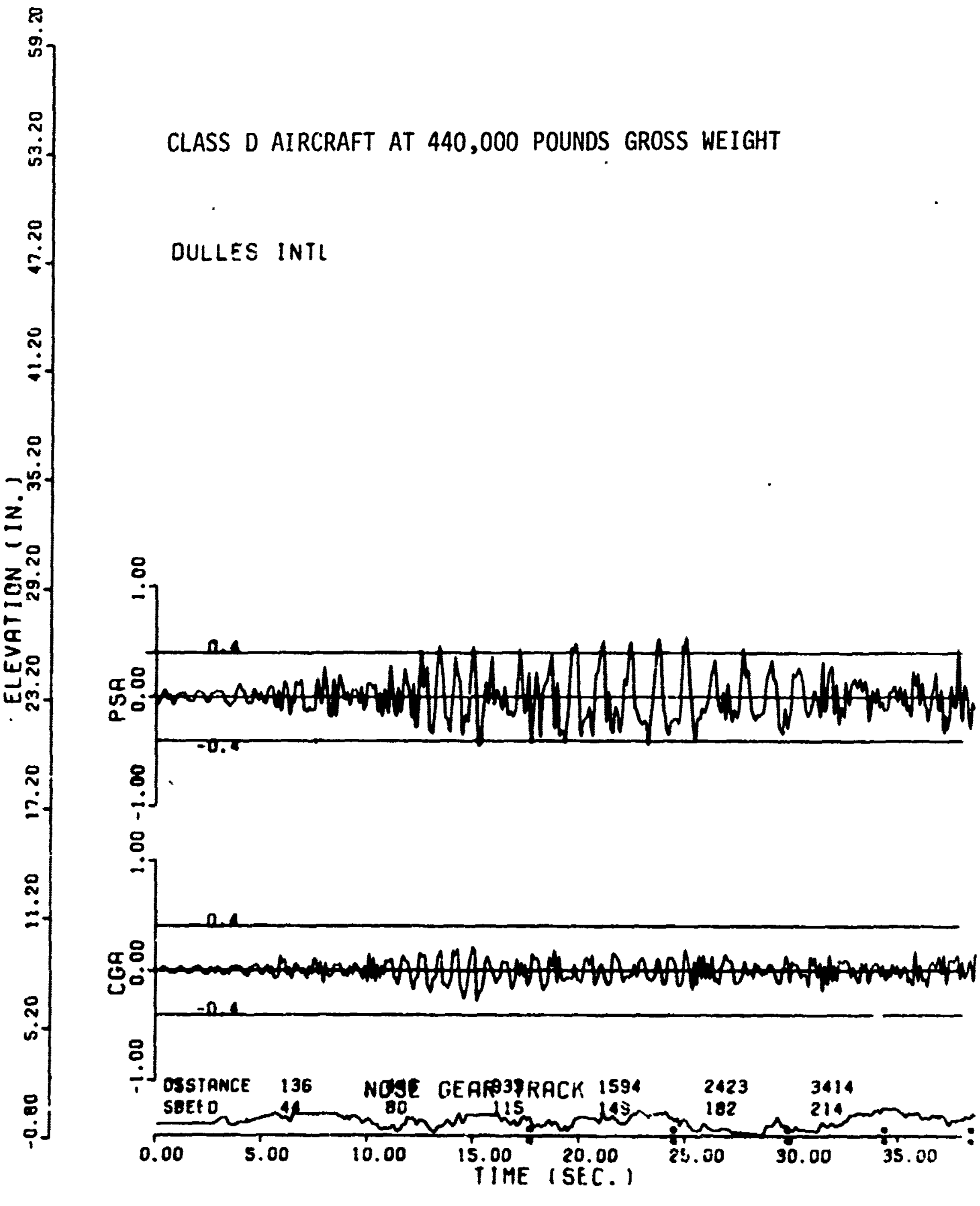


Figure 28. Plotted Results of Class D Aircraft Taking Off from the Dulles Profile

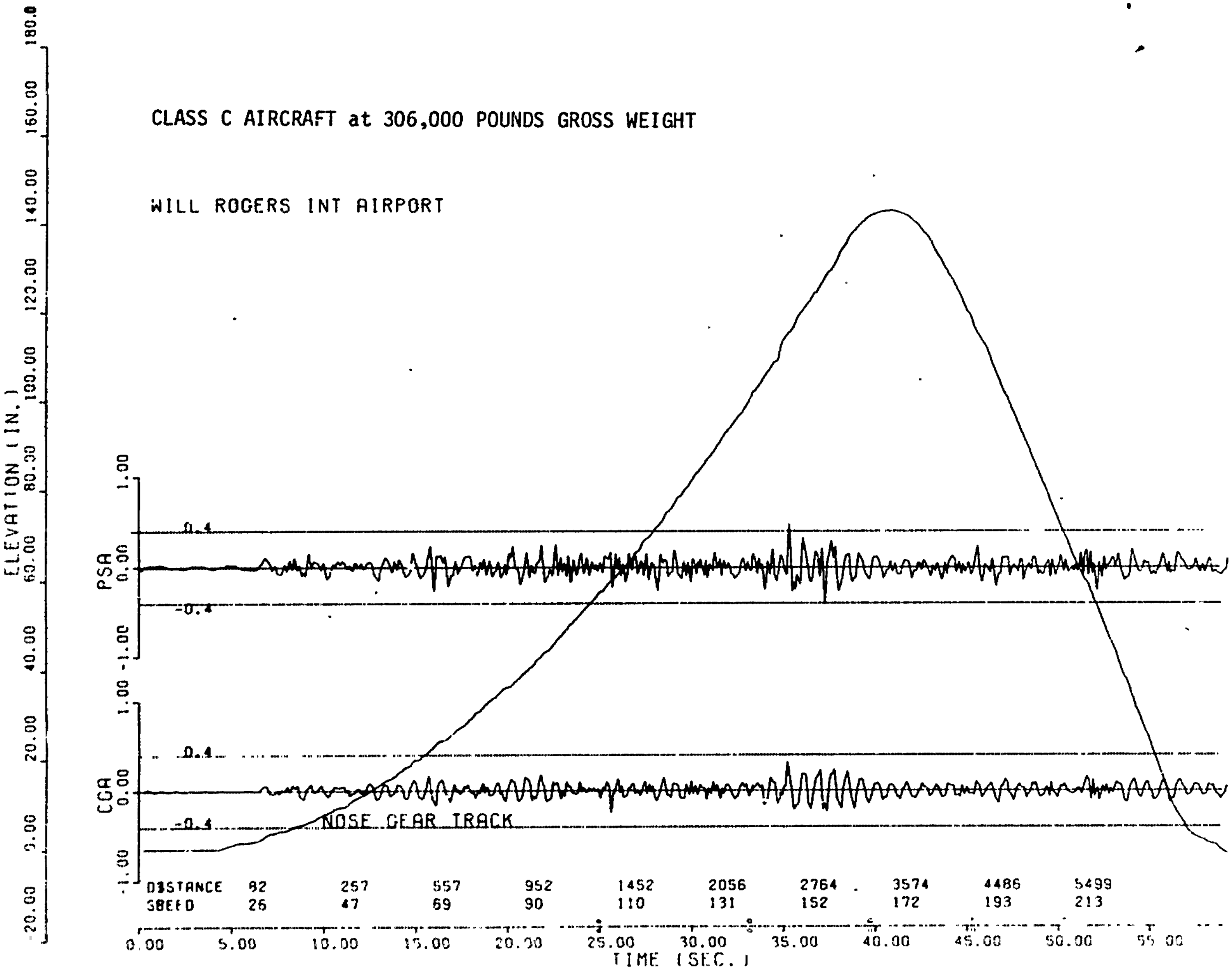


Figure 29. Plotted Results of Class C Aircraft Taking Off from the Will Rogers Profile

CLASS C AIRCRAFT AT 306,000 POUNDS GROSS WEIGHT

DULLES INTL

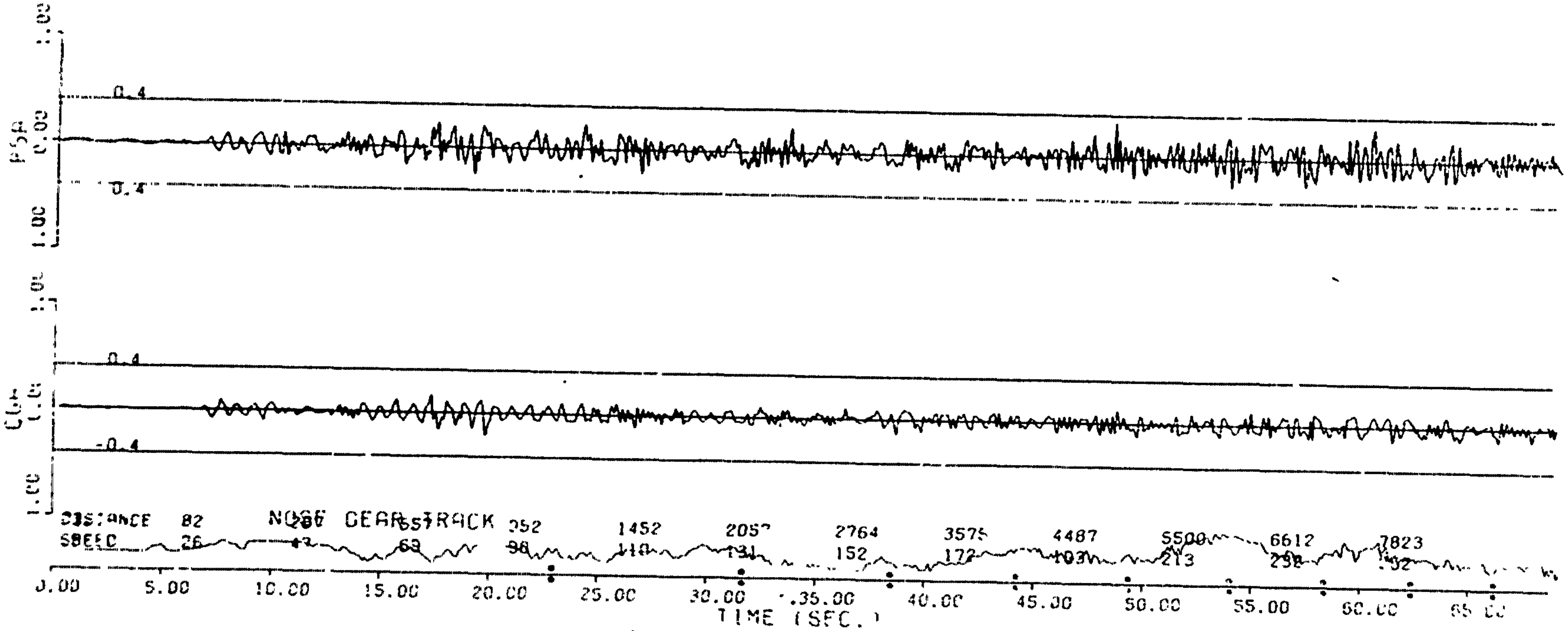


Figure 30. Plotted Results of a Class C Aircraft Taking Off from the Dulles Profile

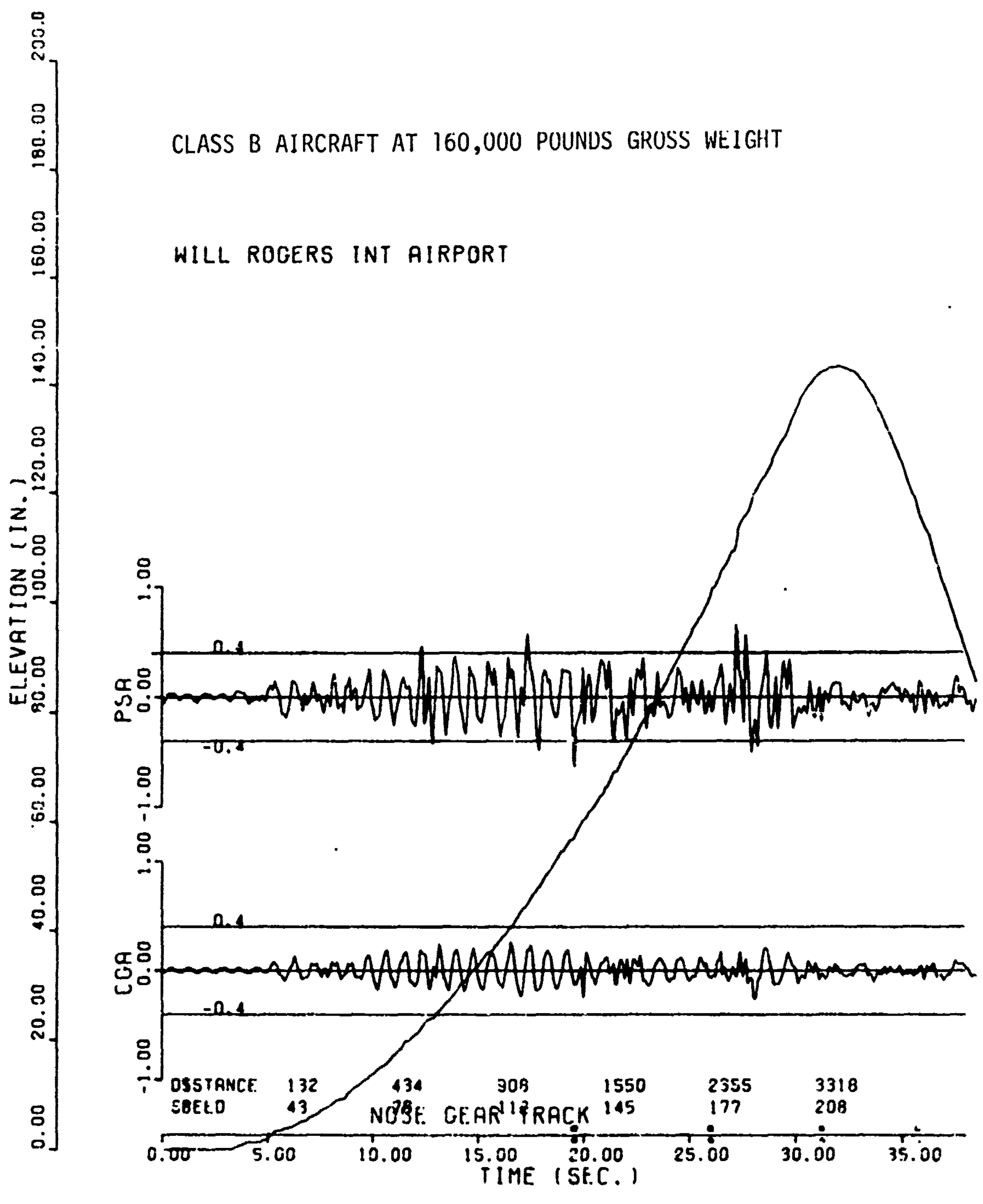


Figure 31. Plotted Results of a Class B Aircraft Taking Off from the Will Rogers Profile

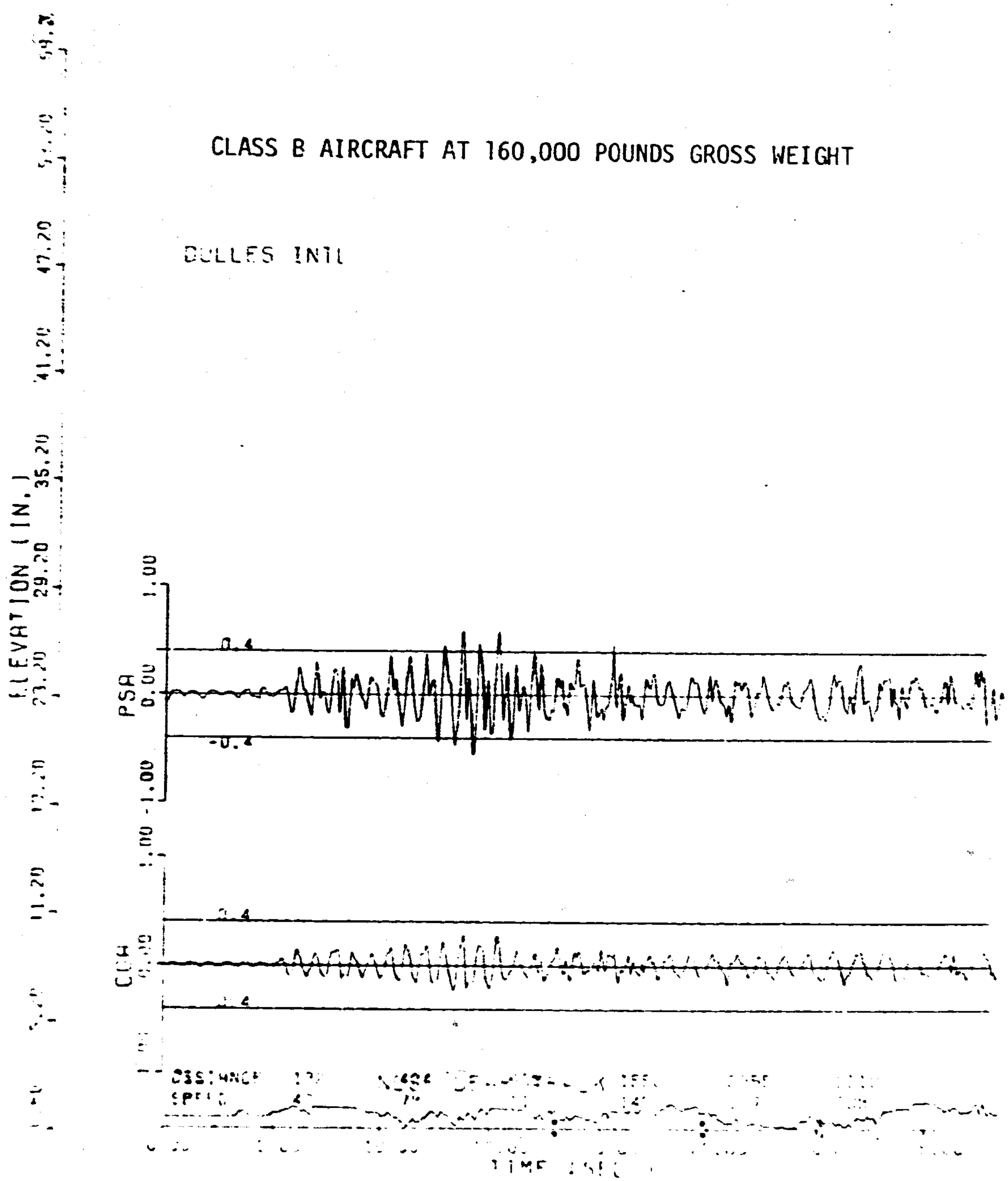


Figure 32. Plotted Results of a Class B Aircraft Taking Off from the Dulles Profile

CLASS B AIRCRAFT AT 160,000 POUNDS GROSS WEIGHT

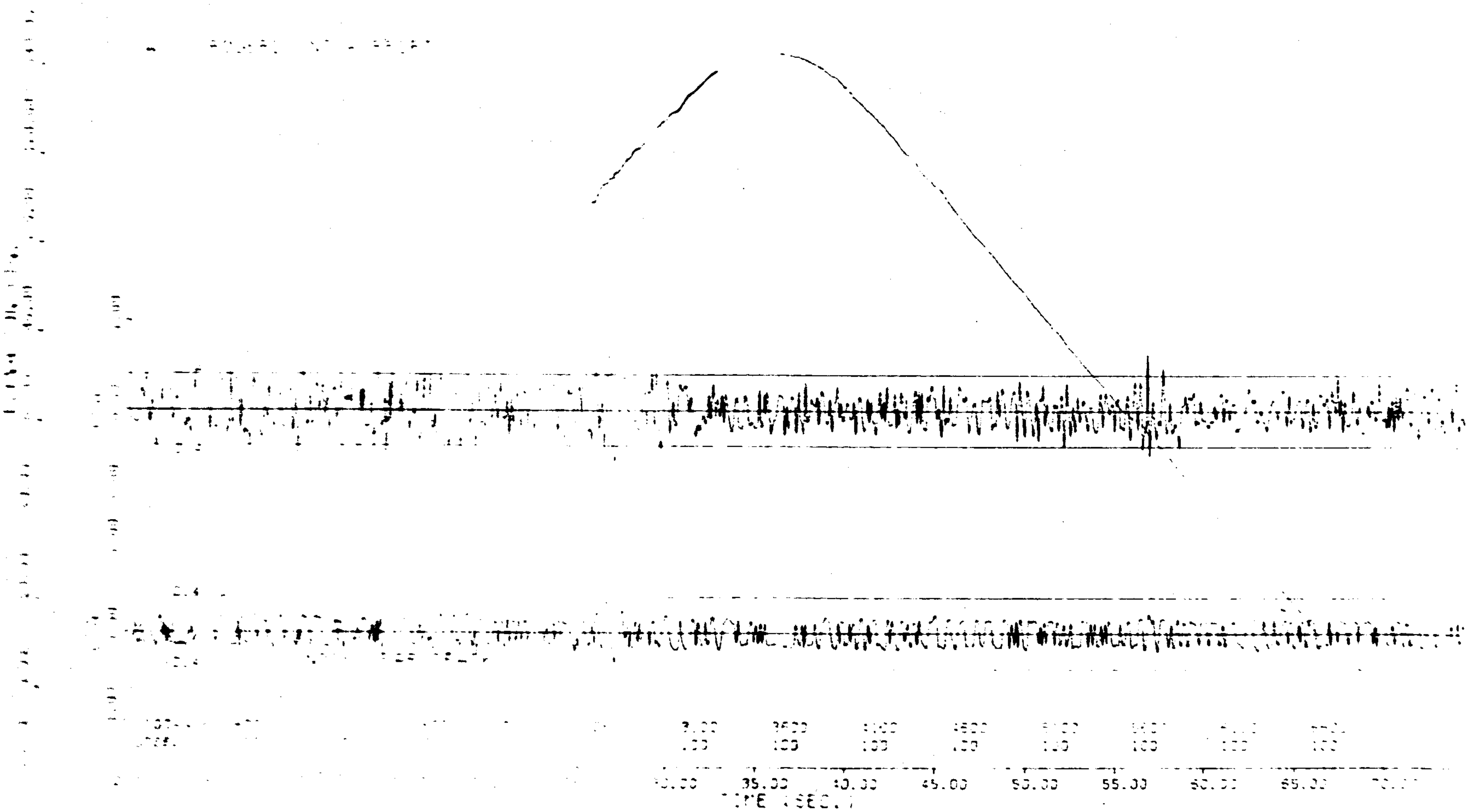


Figure 33. Plotted Results of a Class B Aircraft During Taxi over the Will Rogers Profile with Strut Friction Included

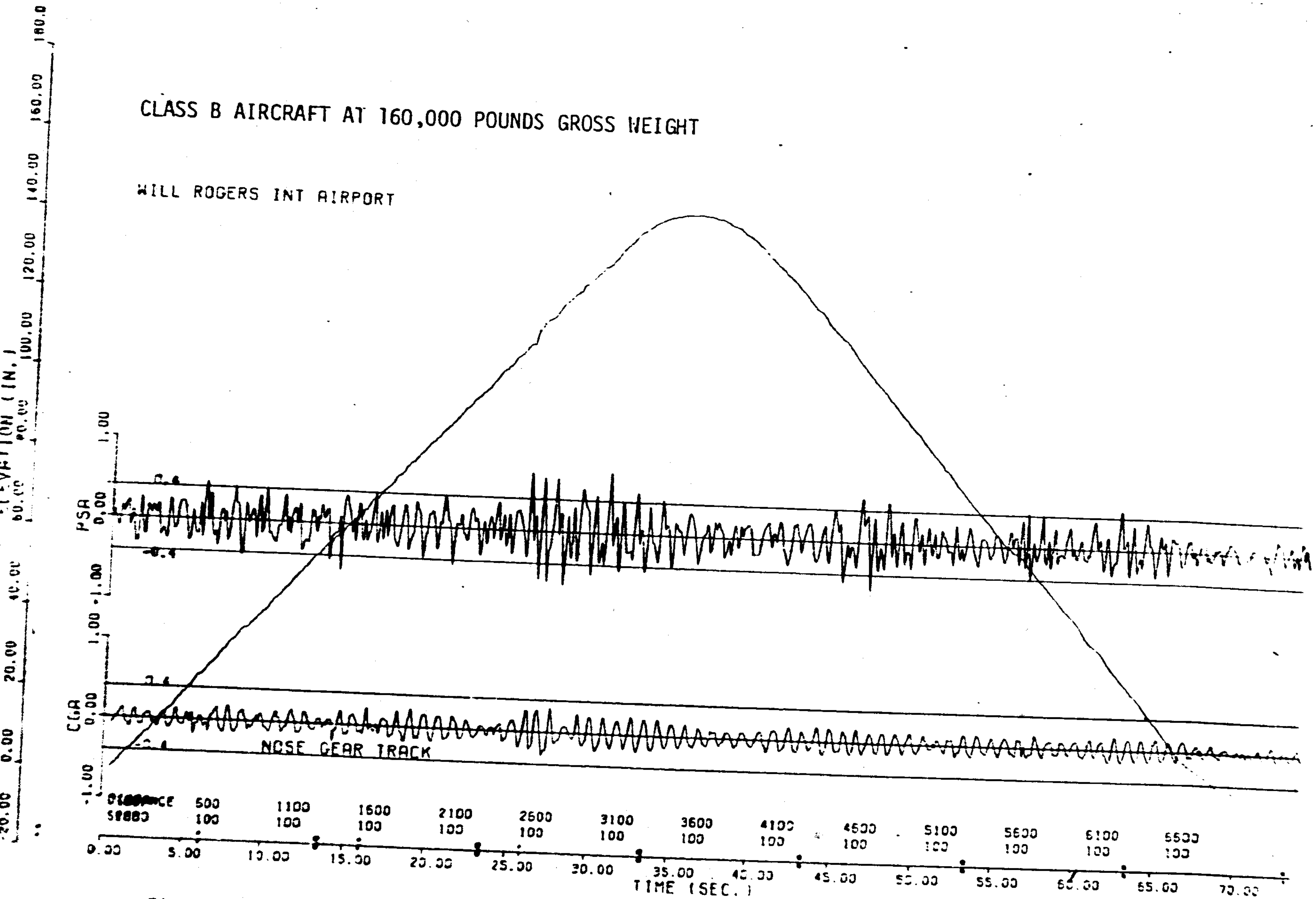


Figure 34. Plotted Results of a Class B Aircraft During Taxi over the Will Rogers Profile without Strut Friction Included

SECTION VI

CONCLUSIONS

Data have been collected and reduced to the form required by the computer program "TAXI" for simulation of five classes of commercial jet aircraft as follows:

Aircraft Class	Gross Weight Range-Pound
Class A	Less than 150,000
Class B	150,000 - 300,000
Class C	300,000 - 450,000
Class D	450,000 - 600,000
Class E	Greater than 600,000

Each of these aircraft has been successfully simulated traversing the profiles of Will Rogers International Airport in Oklahoma City, Oklahoma and Dulles International Airport in Washington DC. Results of these simulations indicate that aircraft response to runway roughness is highly dependent on aircraft parameters such as gear stiffness, gear spacing and the degree of coupling between the rigid body modes of vibration, as well as the degree of runway roughness.

The addition of the strut bearing friction forces in the simulation of Class B aircraft has a small effect on the vertical acceleration level at the pilot's station.

REFERENCES

1. Gerardi, A. G., Lohwasser, A. K., Computer Program for the Prediction of Aircraft Response to Runway Roughness, AFWL-TR-73-109, Volume I and II, Air Force Weapons Laboratory, Kirtland AFB, New Mexico, September 1973.

2. Chance Vought Corporation, A Rational Method for Prediction A Lighting Gear Dynamic Loads, ASD-TDR-62-555, Aeronautical Systems Division, Wright-Patterson AFB, Ohio, December 1963.

APPENDIX A

COMPUTER LISTING FOR THE GENERAL COMPUTER PROGRAM CALLED "TAXI"

```
      PROGRAM TAXI(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,PLOT,TAPE2,    TAXI0010
     1TAPE3)                                                            TAXI0020
************************************************************************TAXI0030
************************************************************************TAXI0040
************************************************************************TAXI0050
C  THIS PROGRAM WILL PERFORM A SYMMETRIC                                TAXI0060
C  DYNAMIC TAXI ANALYSIS ON A FLEXIBLE                                  TAXI0070
C  VEHICLE TRAVERSING A GIVEN RIGID RUNWA                               TAXI0080
C  PROFILE.                                                             TAXI0090
************************************************************************TAXI0100
************************************************************************TAXI0110
************************************************************************TAXI0120
      COMMON/FLEX1/SIMAIN(15),SINOSE(15),SICG(15),SITAIL(15),SIPS(15)   TAXI0130
      COMMON/FLEX2/NFM,GM(15),OMEGA(15)                                 TAXI0140
      COMMON/FLEX3/Q(15),QD(15),QDD(15)                                 TAXI0150
      COMMON/X1/W,WM,WN,WCG,MM,MN,A,B,MMI                               TAXI0160
      COMMON/X2/PAOM,VOM,AAM,AMM,OAM                                    TAXI0170
      COMMON/X3/PAON,VON,AAN,AMN,OAN                                    TAXI0180
      COMMON/X4/SKM,SXN,SLM,SLN,TSM ,TSN                                TAXI0190
      COMMON/X5/CL,CD,AREA,THRUST                                       TAXI0200
      COMMON/X6/Z,REACTM,REACTN,DX,NTRUN                                TAXI0210
      COMMON/X7/AM,BM,CM,DM,AN,BN,CN,DN                                 TAXI0220
      COMMON/X8/STROKM(20),PINDM(20),STROKN(20),PINDN(20),NSCM,NSCN     TAXI0230
      COMMON/X9/FSM,FSN,FTM,FTN,XMAIN,XNOSE,VELM,VELN                   TAXI0240
      COMMON/X10/ZPM,ZPN                                                TAXI0250
      COMMON/X11/ FFM,FFN                                               TAXI0260
      COMMON/Q1/COM,SSM                                                 TAXI0270
      DIMENSION PLANE(8),SITE(8)                                        TAXI0280
      DIMENSION T(12), TD(12), TDD(12)                                  TAXI0290
      DIMENSION ELEV(7000)                                              TAXI0300
      DIMENSION VP(4),VPN(4),DATA(430)                                  TAXI0310
      DIMENSION CGACC(1000), TIME(1000), PSACC(1000), TIME1(1000)       TAXI0320
      DIMENSION PROF(1000),RMARK(20)                                    TAXI0330
      DIMENSION SSPLOT(300), STIME(300),DDPLOT(300)                     TAXI0340
      REAL WCG,MM,MN,MMI                                                TAXI0350
      PSA=0.0                                                           TAXI0360
      CGOUT=0.0                                                         TAXI0370
      LOK=0                                                             TAXI0380
      WDR=0.                                                            TAXI0390
      X=0.                                                              TAXI0400
      LLL = 1                                                           TAXI0410
      LL = 0                                                            TAXI0420
      STORE1 = 0.                                                       TAXI0430
      STORE2 = 0.                                                       TAXI0440
      STORE3 = 0.                                                       TAXI0450
      STORE4 = 0.                                                       TAXI0460
      NN = 0                                                            TAXI0470
      II = 0                                                            TAXI0480
      PP = 1.0                                                          TAXI0490
      N = 1                                                             TAXI0500
      ITT = 0                                                           TAXI0510
************************************************************************TAXI0520
C        READ AND PRINT INPUT DATA                                      TAXI0530
************************************************************************TAXI0540
C    W=VEHICLE WEIGHT AT CG (POUNDS)                                    TAXI0550
C    A=DISTANCE MAIN GEAR TO CG (INCHES)                                TAXI0560
C    B=DISTANCE NOSE GEAR TO CG (INCHES)                                TAXI0570
```

```
C MMI=MASS MOMENT OF INERTIA (LB IN SEC SQ)                        TAXI0580
C  PLANE= AIRPLANE BEING SIMULATED AND  GROSS WEIGHT               TAXI0590
C  PSARM = DISTANCE OF PILOT STATION TO CG                         TAXI0600
C     TAILRM = DISTANCE OF TAIL STATION TO CG                      TAXI0610
C  TAKOFF= TAKE-OFF SPEED (FEET/SEC)                               TAXI0620
C SPEED =INITIAL  VEL  OF  AIRPLANE                                TAXI0630
C  THURST= TOTAL AIRPLANE THRUST                                   TAXI0640
C  CL=LIFT COEFF.                                                  TAXI0650
C  AREA=WING AREA                                                  TAXI0660
C  CD=DRAG COEFF.                                                  TAXI0670
C  WM=WEIGHT OF MAIN GEAR  (EACH)                                  TAXI0680
C  WN=WEIGHT OF NOSE GEAR                                          TAXI0690
C  SXM= NUMBER OF MAIN GEAR STRUTS                                 TAXI0700
C   SXN= NUMBER OF NOSE GEAR STRUTS                                TAXI0710
C AHN  HYDRAULIC PISTON AREA NOSE SQ INCHES                        TAXI0720
C AAN  PNEUMATIC PISTON AREA NOSE SQ INCHES                        TAXI0730
C AHM  HYDRAULIC PISTON AREA MAIN SQ INCHES                        TAXI0740
C AAM  PNEUMATIC PISTON AREA MAIN SQ INCHES                        TAXI0750
C PAON NOSE STRUT PRELOAD PRESSURE  PSI                            TAXI0760
C PAOM MAIN STRUT PRELOAD PRESSURE  PSI                            TAXI0770
C VON  NOSE STRUT INITIAL VOLUME CU. IN.                           TAXI0780
C VOM  MAIN STRUT INITIAL VOLUME CU. IN.                           TAXI0790
C OAM  ORIFACE AREA MAIN                                           TAXI0800
C OAN  ORIFACE AREA NOSE                                           TAXI0810
C SLM=MAIN GEAR STRUT LENGTH UNLOADED INCHES                       TAXI0820
C     DISTANCE FROM CL OF AXLE TO CG LINE                          TAXI0830
C SLN=NOSE GEAR STRUT LENGTH UNLOADED INCHES                       TAXI0840
C     DISTANCE FROM CL OF AXLE TO CG LINE                          TAXI0850
C  TSM    MAIN TIRE SPRING CONSTANT PER STRUT                      TAXI0860
C  TSN    NOSE TIRE SPRING CONSTANT PER STRUT                      TAXI0870
C  DX=TIME STEP SIZE                                               TAXI0880
C  IFPLOT   NO PLOT IF IFPLOT =1.                                  TAXI0890
C  IFLIST   NO LIST IF IFLIST =1.                                  TAXI0900
C  READ METERING PIN DESCRIPTION STARTING AT ZERO STROKE           TAXI0910
C  NSCN=# OF METERING PIN CHANGES NOSE GEAR                        TAXI0920
C  NSCM=# OF METERING PIN CHANGES MAIN GEAR                        TAXI0930
C  NFM = NUMBER OF FLEXIBLE MODES                                  TAXI0940
C  SIXXXX(I) = MODE SHAPE DEFLECTION (NON DIM.)                    TAXI0950
C  GM(I) = GENERALIZED MASS (POUNDS-SEC SQ/IN)                     TAXI0960
C  OMEGA (I) = MODAL FREQUENCIES (RAD/SEC)                         TAXI0970
      READ (5,1) PLANE                                             TAXI0980
 1    FORMAT(8A10)                                                 TAXI0990
      READ(5,5) W,A,B,MMI                                          TAXI1000
 5    FORMAT(3F10.1,F12.8)                                         TAXI1010
      READ(5,10) PSARM,TAILRM                                      TAXI1020
 10   FORMAT(2F10.2)                                               TAXI1030
      READ(5,15) SPEED,THRUST,TAKOFF                               TAXI1040
 15   FORMAT(3F10.3)                                               TAXI1050
      READ(5,20) CL,AREA,CD                                        TAXI1060
 20   FORMAT(3F10.4)                                               TAXI1070
      READ(5,25) WM,WN,SXM,SXN                                     TAXI1080
 25   FORMAT(4F10.2)                                               TAXI1090
      READ(5,30) AHN,AAN,AHM,AAM                                   TAXI1100
 30   FORMAT(4F10.5)                                               TAXI1110
      READ(5,35) PAON,PAOM,VON,VOM,OAM,OAN                         TAXI1120
 35   FORMAT(6F10.5)                                               TAXI1130
      READ(5,40) SLM,SLN                                           TAXI1140
```

```
   40 FORMAT(2F10.3)                                                   TAXI1150
      READ(5,45) TSM ,TSN                                              TAXI1160
   45 FORMAT(2F10.1)                                                   TAXI1170
      READ(5,50)DX                                                     TAXI1180
      READ(5,51) IFPLOT,IFLIST                                         TAXI1190
   50 FORMAT(F10.3)                                                    TAXI1200
      READ(5,51) NSCN                                                  TAXI1210
   51 FORMAT(2I5)                                                      TAXI1220
      READ(5,52) (STROKN(I),PINON(I),I=1,NSCN)                         TAXI1230
   52 FORMAT(2(F10.3))                                                 TAXI1240
      READ(5,51)NSCM                                                   TAXI1250
      READ(5,52) (STROKM(I),PINOM(I),I=1,NSCM)                         TAXI1260
      READ(5,51) NFM                                                   TAXI1270
      READ(5,53) (SIMAIN(I),SINOSE(I),SICG(I),SITAIL(I),SIPS(I)        TAXI1280
     1,I=1,NFM)                                                        TAXI1290
   53 FORMAT(5F10.7)                                                   TAXI1300
      READ(5,54) (GM(I),OMEGA(I),I=1,NFM)                              TAXI1310
   54 FORMAT(F15.3,F10.4)                                              TAXI1320
      MN=WN/386.                                                       TAXI1330
      MM=WM/386.                                                       TAXI1340
      MCG=W/386.                                                       TAXI1350
      TYPRUN = .01                                                     TAXI1360
      IF(SPEED.GT.5.) TYPRUN = .02                                     TAXI1370
      NTRUN=TYPRUN*100.                                                TAXI1380
      WRITE(6,55)                                                      TAXI1390
   55 FORMAT(1H1,46X,*******************************************)     TAXI1400
      WRITE(6,60)                                                      TAXI1410
   60 FORMAT(46X,46H***************** INPUT DATA *****************)    TAXI1420
      WRITE(6,61)                                                      TAXI1430
   61 FORMAT(///1X,41H********* GENERAL AIRCRAFT DATA *********)       TAXI1440
      WRITE(6,62)PLANE                                                 TAXI1450
   62 FORMAT(//,3X,8A10)                                               TAXI1460
      WRITE(6,65) W,WM,WN,A,B,MMI                                      TAXI1470
   65 FORMAT(///,5X,*W=*,F10.1,5X,*WM=*,F10.2,5X,*WN=*,F10.2,5X,       TAXI1480
     1*A=*,F13.3,5X,*B=*,F10.3,5X,*MMI=*,F12.0)                        TAXI1490
      WRITE(6,66) SXM,SXN,SLM,SLN,PSARM,TAILRM                         TAXI1500
   66 FORMAT(//,5X,*SXM=*,F8.1,5X,*SXN=*,F9.1,5X,*SLM=*,F9.1,5X,       TAXI1510
     1*SLN=*,F8.1,5X,*PSARM=*,F7.1,4X,*TAILRM=*,F7.1)                  TAXI1520
      WRITE(6,70) AAM,AMM,PAOM,VOM,OAM,TSM                             TAXI1530
   70 FORMAT(//,5X,*AAM=*,F8.2,5X,*AMM=*,F8.2,6X,*PAOM=*,F9.2,4X,      TAXI1540
     1*VOM=*,F8.2,5X,*OAM=*,F8.2,5X,*TSM =*,F10.2)                     TAXI1550
      WRITE(6,74) AAN,AMN,PAON,VON,OAN,TSN                             TAXI1560
   74 FORMAT(//,5X,*AAN=*,F8.2,5X,*AMN=*,F8.2,6X,*PAON=*,F9.2,4X,      TAXI1570
     1*VON=*,F8.2,5X,*OAN=*,F8.2,5X,*TSN =*,F10.2)                     TAXI1580
      WRITE(6,75) CL,CD,AREA,SPEED,THRUST,TAKOFF                       TAXI1590
   75 FORMAT(//,5X,*CL=*,F9.3,5X,*CD=*,F9.3,6X,*AREA=*,F8.2,5X,        TAXI1600
     1*SPEED=*,F7.1,4X,*THRUST=*,F7.0,3X,*TAKOFF=*,F10.2)              TAXI1610
      WRITE(6,76) (STROKN(I),PINON(I),I=1,NSCN)                        TAXI1620
   76 FORMAT(//,3X,*STROKE NOSE   PIN DIAMETER   *//,2(3X,F10.3))      TAXI1630
      WRITE(6,77) (STROKM(I),PINOM(I),I=1,NSCM)                        TAXI1640
   77 FORMAT(//,3X,*STROKE MAIN   PIN DIAMETER   *//,2(3X,F10.3))      TAXI1650
      WRITE(6,80)                                                      TAXI1660
   80 FORMAT(1H1,1X,*MODE   SIPS   SINOSE*,4X,*  SICG   SIMAIN  SITAIL TAXI1670
     1OMEGA   GEN. MASS*)                                              TAXI1680
      DO 85  I=1,NFM                                                   TAXI1690
   85 WRITE(6,90) (I,SIPS(I),SINOSE(I),SICG(I),SIMAIN(I),SITAIL(I),    TAXI1700
     1OMEGA(I),GM(I))                                                  TAXI1710
```

```
   90    FORMAT(//,    2X,I2,6(F7.2,2X),F10.1)                        TAXI1720
C ZMI =INITIAL MAIN GEAR POSITION INCHES                              TAXI1730
         WRITE(6,95)                                                  TAXI1740
   95    FORMAT(///,46X,40H********* INTIAL CONDITIONS ************)  TAXI1750
C ZNI =INITIAL NOSE GEAR POSITION INCHES                              TAXI1760
C ZCGI=INITIAL C.G. POSITION INCHES                                   TAXI1770
C THETAI=INITIAL PITCH ANGLE DEGREES                                  TAXI1780
C   THE ABOVE PARAMETERS ARE CALCULATED IN SUBROUTINE IC              TAXI1790
         CALL IC(  ZCGI,ZMI,ZNI,THETAI)                               TAXI1800
         WRITE(6,105) ZMI,ZNI,THETAI,ZCGI                             TAXI1810
  105    FORMAT(//,5X,4HZMI=,F10.3,5X,4HZNI=,F10.3,5X,7HTHETAI=,F10.6, TAXI1820
        15X,5HZCGI=,F10.3)                                            TAXI1830
         REACTN=(ZNI*TSN )*SXN                                        TAXI1840
         REACTM=(ZMI*TSM )*SXM                                        TAXI1850
         WRITE(6,106) XMAIN,XNOSE,REACTN,REACTM                       TAXI1860
  106    FORMAT (/,3X,*XMAIN=*,F8.3,3X,*XNOSE=*,F8.3,3X,*REACTN=*,F10.0, TAXI1870
        13X,*REACTM=*,F10.0)                                          TAXI1880
*****************************************************************TAXI1890
C READ RUNWAY PROFILE DATA (ELEV)                                     TAXI1900
C   SITE= RUNWAY PROFILE AND DIRECTION                                TAXI1910
C  NPTSS=# OF RUNWAY ELEVATION DATA POINTS                            TAXI1920
         WRITE (6,111)                                                TAXI1930
  111    FORMAT(*T*)                                                  TAXI1940
         DO 112 I=1,50                                                TAXI1950
  112    ELEV(I)=0.0                                                  TAXI1960
         READ(2,1) SITE                                               TAXI1970
         READ(2,116) NPTSS                                            TAXI1980
         NPTSS=NPTSS+50                                               TAXI1990
  116    FORMAT(I6)                                                   TAXI2000
         LD=51                                                        TAXI2010
  117    LSD = LD + 9                                                 TAXI2020
         READ(2,118) (ELEV(I),I=LD,LSD)                               TAXI2030
  118    FORMAT(10F7.3)                                               TAXI2040
         N10=LD                                                       TAXI2050
         IF(LSD.GE.NPTSS) GO TO 120                                   TAXI2060
         LD=LD+10                                                     TAXI2070
         GO TO 117                                                    TAXI2080
  120    ELEV1=ELEV(51)                                               TAXI2090
         DO 125 I=51,N10                                              TAXI2100
  125    ELEV(I) = (ELEV(I)-ELEV1)*12.0                               TAXI2110
         DISTAN=0.                                                    TAXI2120
         LSD=LSD-50                                                   TAXI2130
         SLP=(LSD-50)*2                                               TAXI2140
         SLP=ELEV(LSD)/SLP                                            TAXI2150
         DO 126 I=51 ,N10                                             TAXI2160
         ELEV(I)=ELEV(I)-SLP*DISTAN                                   TAXI2170
  126    DISTAN=DISTAN+2.                                             TAXI2180
         IVAL=(A+B)/24.                                               TAXI2190
         WRITE(6,130)                                                 TAXI2200
  130    FORMAT(1H1,5X,*  RUNWAY PROFILE DATA NORMALIZED (SLOPE REMOVED)* TAXI2210
        150X,*FEET DOWN THE RUNWAY*)                                  TAXI2220
         WRITE(6,1) SITE                                              TAXI2230
         LD1=1                                                        TAXI2240
  135    LSD1 = LD1 + 9                                               TAXI2250
         LPRIN = LSD1 * 2                                             TAXI2260
         WRITE(6,140) (ELEV(I),I=LD1,LSD1),LPRIN                      TAXI2270
  140    FORMAT(3X,10F10.5,10X,I8)                                    TAXI2280
```

```
      LD1=LD1+10                                                 TAXI2290
      IF(LD1.GE.N10) GO TO 145                                   TAXI2300
      GO TO 135                                                  TAXI2310
  145 WRITE(6,150) LD1                                           TAXI2320
  150 FORMAT(42H********** END RUNWAY DATA ********** LD1=,I5)   TAXI2330
      ENDRUN = NPTSS*2                                           TAXI2340
      NRN=(ENDRUN-100.)/1000.                                    TAXI2350
      RN=(((ENDRUN-100.)-FLOAT(NRN*1000))/2.)+1100.              TAXI2360
      ENDRUN=ENDRUN-90.                                          TAXI2370
      T(2) =ZCGI                                                 TAXI2380
      TD(2) = 0.                                                 TAXI2390
      T(4) = ZMI                                                 TAXI2400
      TD(4) = 0.                                                 TAXI2410
      T(6) = ZNI                                                 TAXI2420
      TD(6) = 0.                                                 TAXI2430
      T(8) = THETAI                                              TAXI2440
      TD(8) = 0.                                                 TAXI2450
      T(10) = 0.                                                 TAXI2460
      TD(10) = SPEED                                             TAXI2470
      IF(IFLIST.EQ.1)  GO TO 156                                 TAXI2480
      WRITE(3,155)                                               TAXI2490
  156 CONTINUE                                                   TAXI2500
  155  FORMAT(1H1,7X,*   XMAIN      XNOSE       FSM          FSN TAXI2510
     1   TAILAC        SPEED      DIST.       CGACC         PSA    TIMTAXI2520
     2E*)                                                        TAXI2530
      DZ=0.                                                      TAXI2540
      ZPM=0.                                                     TAXI2550
      ZPN=0.                                                     TAXI2560
      ZDOT=0.                                                    TAXI2570
      ZNDOT=0.                                                   TAXI2580
      J=1                                                        TAXI2590
  160 YP(1) = ZDOT                                               TAXI2600
      YP(2)=ELEV(J)                                              TAXI2610
      YP(3)=ELEV(J+1)                                            TAXI2620
      YP(4)=ELEV(J+2)                                            TAXI2630
      YPN(1)=ZNDOT                                               TAXI2640
      YPN(2)=ELEV(IVAL)                                          TAXI2650
      YPN(3)=ELEV(IVAL+1)                                        TAXI2660
      YPN(4)=ELEV(IVAL+2)                                        TAXI2670
      Z=DZ                                                       TAXI2680
      CALL COEFF (YPN,AN,BN,CN,DN)                               TAXI2690
      CALL COEFF (YP,AM,BM,CM,DM)                                TAXI2700
      ZDOT=BM                                                    TAXI2710
      ZNDOT=BN                                                   TAXI2720
      IF(M.GT.1) GO TO 245                                       TAXI2730
      M = M + 1                                                  TAXI2740
  165 IF(IFLIST.EQ.1)  GO TO 166                                 TAXI2750
       WRITE(4,170) XMAIN,XNOSE,FSM,FSN,TAILAC,TD(10),T(10),     TAXI2760
     1CGOUT ,PSA,X                                               TAXI2770
C      WRITE(5,170) XMAIN,XNOSE,FSM,FSN,FFM   ,FFN   ,T(10),     TAXI2780
C    1CGOUT ,PSA,X                                               TAXI2790
  166 CONTINUE                                                   TAXI2800
  170  FORMAT(1X,2(3X,F10.3),2(3X,F10.0),5(3X,F10.3),3X,F6.2)    TAXI2810
      TIMEX=0.                                                   TAXI2820
*************************************************************** TAXI2830
      IF(IFPLOT.EQ.1) GO TO 220                                  TAXI2840
      IF(ABS(CGOUT ).LE.ABS(STORE2).AND.ABS(STORE2).GE.ABS(STORE1))  TAXI2850
```

```
      1GO TO 180
  175  STORE1 = STORE2
       STORE2 = CGOUT
       GO TO 190
  180  IF(X-TIME(NN).GT..08) GO TO 185
       IF(ABS(STORE2).GT..30000) GO TO 185
       GO TO 175
  185  NN = NN + 1
       CGACC(NN) = STORE2
       PROF(NN) = ZPN
       TIME(NN) = X - 10. * DX
       IF(TIME(NN).LT.0.) TIME(NN) = .01
       STORE1 = STORE2
       STORE2 = CGOUT
  190  IF(ABS(PSA).LE.ABS(STORE4).AND.ABS(STORE4).GE.ABS(STORE3))
      1GO TO 205
  200  STORE3 = STORE4
       STORE4 = PSA
       GO TO 215
  205  IF(X-TIME1(LL).GT..09) GO TO 210
       IF(ABS(STORE4).GT..32) GO TO 210
       GO TO 200
  210  LL = LL + 1
       PSACC(LL) = STORE4
       TIME1(LL)=X - 10*DX
       IF(TIME1(LL).LE.0.) TIME1(LL) = .001
       STORE3 = STORE4
       STORE4 = PSA
  215  IF(ABS(T(10)-RM).LT.5.0) GO TO 220
       GO TO 225
  220  II = II + 1
       KMARK(II) = X/5.
       RM = RM + 1000.
       ITT = II
  225  IF(HOR.LE.80.) GO TO 235
       HOR=0.
       WRITE(6,155)
  235  HOR = HOR + 1.
  240  X = X + DX
       IF(ABS(X-PP).GT..0009) GO TO 230
       SSPLOT(LLL) = TD(10)
       STIME(LLL) = X/5.
       DDPLOT(LLL) = T(10)
       LLL = LLL + 1
       PP = PP + 5.0
*********************************************************************
  230  CONTINUE
       CALL TAYLOR(T,TD,TDD)
       IF(T(10).GE.ENDRUN) GO TO 260
       IF(X.GE.300.) GO TO 263
       TIMEX=TIMEX+DX
        QDDCG=0.
       QDDPS=0.
       QDDTAL=0.
       DO 241 I=1,NFM
        QDDTAL=QDDTAL+QDD(I)*SITAIL(I)
       QDDCG=QDDCG+QDD(I)*SICG(I)
```

```
  241   QDDPS=QDDPS+QDD(I)*SIPS(I)                                      TAXI3430
        TAILAC=(TDD(2)+TAILRM*TDD(8))/386. +QDDTAL/386.                 TAXI3440
        PSA=(TDD(2)-PSARM*TDD(8))/386.     +QDDPS/386.                  TAXI3450
        CGOUT=TDD(2)/386.   +QDDCG/386.                                 TAXI3460
        IF(TD(10).GE.TAKOFF) GO TO 250                                  TAXI3470
        IF(Z.LT.4.) GO TO 245                                           TAXI3480
        DZ=Z-4.                                                         TAXI3490
        J=J+2                                                           TAXI3500
        IVAL=IVAL+2                                                     TAXI3510
        GO TO 160                                                       TAXI3520
  245   IF(TIMEX.LT.DEETE ) GO TO 240                                   TAXI3530
        DEETE=.02                                                       TAXI3540
        GO TO 165                                                       TAXI3550
  250   WRITE(6,255)                                                    TAXI3560
  255   FORMAT(5X,* THE VEHICLE HAS TAKEN OFF*)                         TAXI3570
  260   WRITE(6,262) ENDRUN,T(10)                                       TAXI3580
  262   FORMAT(3X,* END OF RUNWAY*,2F10.3)                              TAXI3590
*********************************************************************TAXI3600
  263   WGM = X                                                         TAXI3610
        PSRMS=0.                                                        TAXI3620
        CGRMS=0.                                                        TAXI3630
        DO 261 I=1,NN                                                   TAXI3640
  261   CGRMS=CGRMS+CGACC(I)**2                                         TAXI3650
        DO 264 I=1,LL                                                   TAXI3660
  264   PSRMS=PSRMS+PSACC(I)**2                                         TAXI3670
        PSRMS=100.*SQRT(PSRMS)/FLOAT(LL)                                TAXI3680
        CGRMS=100.*SQRT(CGRMS)/FLOAT(NN)                                TAXI3690
        WRITE(6,268) PSRMS,CGRMS                                        TAXI3700
  268    FORMAT(//,,3X,*100 PSRMS=*,F10.3,10X,*100 CGRMS=*,F10.3)       TAXI3710
        IF(IFPLOT.EQ.1) GO TO 285                                       TAXI3720
        XLONG = FLOAT(WGM)/5.                                           TAXI3730
        WRITE(6,265) NN,LL                                              TAXI3740
  265   FORMAT(2I20)                                                    TAXI3750
        IF(NN.LE.1000.OR.LL.LE.1000) GO TO 266                          TAXI3760
        WRITE(6,267)                                                    TAXI3770
  267   FORMAT(3X,*THE ARRAYS CGACC OR PSACC OR PROF HAVE EXCEEDED      TAXI3780
      1 THEIR DIMENSIONED SIZE*)                                        TAXI3790
  266   CALL PLOQQ(DATA,430)                                            TAXI3800
        CALL FACTOR (2.0)                                               TAXI3810
        CALL PLOT(0.0,-11.0,-3)                                         TAXI3820
        CALL PLOT(3.,.7,-3)                                             TAXI3830
        TIME(NN+1) = 0.0                                                TAXI3840
        TIME(NN+2) = 5.0                                                TAXI3850
        TIME1(LL+1)  =0.0                                               TAXI3860
        TIME1(LL+2) = 5.0                                               TAXI3870
        CGACC(NN+1) = -1.0                                              TAXI3880
        CGACC(NN+2) = 1.0                                               TAXI3890
        PSACC(LL+1)= -1.0                                               TAXI3900
        PSACC(LL+2) = 1.0                                               TAXI3910
        CALL SCALE(PROF,10.,NN,1)                                       TAXI3920
        PROF10 = PROF(NN+2) *10.                                        TAXI3930
        IF(PROF10.GT.10.5) GO TO 270                                    TAXI3940
        PROF(NN+2) = 6.0                                                TAXI3950
        IF(NPTSS.GE.1000) GO TO 270                                     TAXI3960
        DO 269 I=1,NN                                                   TAXI3970
  269   PROF(I)=PROF(I)+36.                                             TAXI3980
  270   CALL AXIS(0.,0.,1-*TIME (SEC.),-11,XLONG,0.0,TIME(N  ),         TAXI3990
```

```
     1TIME(NN+2))                                                  TAXI4000
      IXLONG = XLONG                                               TAXI4010
      CALL PLOT (XLONG,1.1,3)                                      TAXI4020
      CALL PLOT (0.,1.1,2)                                         TAXI4030
      CALL SYMBOL (.1,.4,.105,8HDISTANCE,0.,8)                     TAXI4040
      CALL SYMBOL (.1,.2,.105,5HSPEED,0.,5)                        TAXI4050
      DO 275  I=1,IXLONG                                           TAXI4060
      CALL NUMBER(STIME(I),.2,.105,SSPLOT(I),0.0,-1)               TAXI4070
  275 CALL NUMBER(STIME(I),.4,.105,DDPLOT(I),0.0,-1)               TAXI4080
      CALL PLOT (XLONG,1.5,3)                                      TAXI4090
      CALL PLOT (0.,1.5,2)                                         TAXI4100
      DO 280 I=1,JJT                                               TAXI4110
  280 CALL SYMBOL(RMARK(I),-.1,.245,14,0.0,1)                      TAXI4120
      CALL PLOT (XLONG,1.9,3)                                      TAXI4130
      CALL PLOT (0.,1.9,2)                                         TAXI4140
      CALL SYMBOL(0.,9.,.14,PLANE,0.,40)                           TAXI4150
      CALL SYMBOL(0.,8.,.14,SITE,0.,40)                            TAXI4160
      CALL SYMBOL(4.,7.,.14,10H100*CGRMS=,0.,10)                   TAXI4170
      CALL SYMBOL(4.,6.5,.14,10H100*PSRMS=,0.,10)                  TAXI4180
      CALL NUMBER(5.5,7.,.14,CGRMS,0,1)                            TAXI4190
      CALL NUMBER(5.5,6.5,.14,PSRMS,0,1)                           TAXI4200
      XLONG2=XLONG/2.                                              TAXI4210
      CALL SYMBOL(XLONG2,8.5,.14,11HAFFDL -FYS-,0.,11)             TAXI4220
      CALL SYMBOL(XLONG2,7.5,.14,10HWPAFB OHIO,0.,10)              TAXI4230
      CALL PLOT(0.,1.5,-3)                                         TAXI4240
      CALL AXIS(0.,-1.,3HCGA,3,2.0,90.,CGACC(NN+1),CGACC(NN+2))    TAXI4250
      CALL NUMBER(0.4,-.4,.105,-.4,00.0,1)                         TAXI4260
      CALL NUMBER(0.5,.4,.105,+.4,00.0,1)                          TAXI4270
      CALL PLOT(0.,-1.0,-3)                                        TAXI4280
      CALL LINE(TIME,CGACC,NN,1,0,74)                              TAXI4290
      CALL PLOT (XLONG,3.1,3)                                      TAXI4300
      CALL PLOT (0.,3.1,2)                                         TAXI4310
      CALL PLOT(0.,3.5,-3)                                         TAXI4320
      CALL AXIS(0.,-1.,3HPSA,3,2.0,90.,PSACC(LL+1),PSACC(LL+2))    TAXI4330
      CALL PLOT(0.,3.,3)                                           TAXI4340
      CALL PLOT(XLONG,0.,2)                                        TAXI4350
      CALL PLOT (XLONG,.4,3)                                       TAXI4360
      CALL PLOT (-.1,.4,2)                                         TAXI4370
      CALL NUMBER(0.5,.4,.105,+.4,00.0,1)                          TAXI4380
      CALL NUMBER(0.4,-.5,.105,-.4,00.0,1)                         TAXI4390
      CALL PLOT(0.,-1.0,-3)                                        TAXI4400
      CALL LINE(TIME1,PSACC,LL,1,0,74)                             TAXI4410
      CALL PLOT(0.,-3.0,-3)                                        TAXI4420
      CALL AXIS(-1.0,0.,15HELEVATION (IN.),15,10.0,90.0,PROF(NN+1),TAXI4430
     1PROF(NN+2))                                                  TAXI4440
      CALL PLOT(5.,0.,-3)                                          TAXI4450
      XPROF=.25+ABS(PROF(NN+1))/PROF(NN+2)                         TAXI4460
      CALL SYMBOL (2.,XPROF,.14,15HNOSE GEAR TRACK,0.,15)          TAXI4470
      CALL LINE(TIME,PROF,NN,1,0,74)                               TAXI4480
      XSTOP=XLONG+5.                                               TAXI4490
      CALL PLOT (XSTOP,0.,-3)                                      TAXI4500
      WRITE(6,290)                                                 TAXI4510
      CALL PLOTE                                                   TAXI4520
  285 STOP                                                         TAXI4530
  290 FORMAT(*S*)                                                  TAXI4540
      END                                                          TAXI4550
```

```
SUBROUTINE TAYLOR      74/74    OPT=1                         FTN 4.2+P380       05/13/75  17.47.44.       PAGE     1

              SUBROUTINE TAYLOR(T,TD,TDD)                                          TAY 0010
              COMMON/FLEX1/SINAIN(15),SINOSE(15),SIGG(15),SITAIL(15),SIPS(15)      TAY 0020
              COMMON/FLEX2/NFM,GM(15),OMEGA(15)                                    TAY 0030
              COMMON/FLEX3/Q(15),QD(15),QDD(15)                                    TAY 0040
              COMMON/X1/W,WM,WN,MCG,MM,MN,A,B,MMI                                  TAY 0050
              COMMON/X2/PAOM,VOM,AAM,AHM,OAM                                       TAY 0060
              COMMON/X3/PAON,VON,AAN,AHN,OAN                                       TAY 0070
              COMMON/X4/SXM,SXN,SLM,SLN,TSM ,TSN                                   TAY 0080
              COMMON/X5/CL,CD,AREA,THRUST                                          TAY 0090
              COMMON/X6/Z,REACTM,REACTN,DX,WTRUN                                   TAY 0100
              COMMON/X7/AM,BM,CM,DM,AN,BN,CN,DN                                    TAY 0115
              COMMON/XA/STROKM(20),PINDM(20),STROKN(20),PINDN(20),NSCM,NSCN        TAY 0123
              COMMON/X9/FSM,FSN,FTM,FTN,XMAIN,XNOSE,VELM,VELN                      TAY 0130
              COMMON/X10/ZPM,ZPN                                                   TAY 0140
              COMMON/OL/COM,SSM                                                    TAY 0150
              DIMENSION T(12), TD(12), TDD(12)                                     TAY 0160
              REAL MCG,MM,MN,MMI                                                   TAY 0170
            1 Z=Z+TD(10)*DX+TDD(10)*DX**2/2.                                       TAY 0180
          120 ZPM=AM+BM*Z+CM*Z**2+DM*Z**3                                          TAY 0190
              ZPN=AN+BN*Z+CN*Z**2+DN*Z**3                                          TAY 0200
               QTN=0.                                                              TAY 0210
              QTM=0.                                                               TAY 0220
              QTDM=0.                                                              TAY 0230
               QTDN=0.                                                             TAY 0240
               DO 130 I=1,NFM                                                      TAY 0250
               QTN=QTN+Q(I)*SINOSE(I)                                              TAY 0260
              QTM=QTM+Q(I)*SIMAIN(I)                                               TAY 0270
               QTDM=QTDM+QD(I)*SIMAIN(I)                                           TAY 0280
          130  QTDN=QTDN+QD(I)*SINOSE(I)                                           TAY 0290
              XNOSE = (T(2) - B * T(8) - T(6)) +QTN                                TAY 0300
              XMAIN = (T(2) + A * T(8) - T(4)) +QTM                                TAY 0310
              VELM = TD(2) + A * TD(8) - TD(4) +QTDM                               TAY 0320
              VELN = TD(2) - B * TD(8) - TD(6) +QTDN                               TAY 0330
              IF(XMAIN.GE.0.) XMAIN=-.1                                            TAY 0340
              IF(XNOSE.GE.0.) XNOSE=-.1                                            TAY 0350
              IF(VELM.EQ.0.) VELM=-.1                                              TAY 0360
              IF(VELN.EQ.0.) VELN=-.1                                              TAY 0370
              XMLK=ABS(XMAIN)                                                      TAY 0380
              XNLK=ABS(XNOSE)                                                      TAY 0390
        C  NOSE AND MAIN DAMPING COEFF                                             TAY 0400
              CALL TLOOK(XNLK,SLOPEN,YCEPN,STROKN,PINDN,NSCN)                      TAY 0410
              CALL TLOOK(XMLK,SLOPEM,YCEPM,STROKM,PINDM,NSCM)                      TAY 0420
              AOM = OAM -ABS((SLOPEM*XMLK+YCEPM)**2)*.78539                        TAY 0430
              AON = OAN -ABS((SLOPEN*XNLK+ YCEPN)**2)*.78539                       TAY 0440
              CON=(.00080*(AHN**3.))/(2.*(.9*AON)**2)                              TAY 0450
              COM=(.00080*(AHM**3.))/(2.*(.9*AOM)**2)                              TAY 0460
        C  NOSE AND MAIN STRUT PNEUMATIC FORCES                                    TAY 0470
              SSM=(PAOM*VOM)/(((VOM/AAM)-XMLK))                                    TAY 0480
              SSN=(PAON*VON)/(((VON/AAN)-XNLK))                                    TAY 0490
              FTM = SXM * TSM * (T(4) - ZPM)                                       TAY 0500
              FTN =SXN* TSN * (T(6) - ZPN)                                         TAY 0510
              IF(FTN.GT.0.)FTN=0.                                                  TAY 0520
              IF(FTM.GT.0.)FTM=0.                                                  TAY 0530
              FSN=SXN*(-SSN+CON*VELN*ABS(VELN) )                                   TAY 0540
              FSM=SXM*(-SSM +COM*VELM*ABS(VELM) )                                  TAY 0550
              VLIFT =.001189*CL*AREA*(TD(10)*TD(10))                               TAY 0560
              DRAGA=VLIFT*CD/CL                                                    TAY 0570
```

```
SUBROUTINE TAYLOR      74/74    OPT=1                          FTN 4.2+P380        05/13/75  17.47.44.        PAGE     2

                 DRAGT =ABS(.025*FTM+.025*FTN)                                 TAY 0580
                 IF(NTRUN.EQ.1) GO TO 125                                      TAY 0590
                 THRUST=DRAGA+DRAGT                                            TAY 0600
            125  TDD(2) = (-FSN-FSM-MCG*386.+VLIFT)/MCG                        TAY 0610
                 TDD(4)=(FSM-FTM-386.*SXM*MM)/(MM*SXM)                         TAY 0620
                 TDD(6)=(FSN-FTN-MN*386.*SXN)/(MN*SXN)                         TAY 0630
                 TDD(8) =-(FSM*A -FSN*B -DRAGT *(SLM+XMAIN))/MMI               TAY 0640
                 TDD(10) = (THRUST-DRAGA-DRAGT)/((MCG*12.))                    TAY 0650
                 DO 200 I=1,NFM                                                TAY 0660
            200   QDD(I)=-(SIMAIN(I)*(FSM-REACTM)+SINOSE(I)*(FSN-REACTN)       TAY 0670
                1+.10*OMEGA(I)*QD(I)*GM(I)+OMEGA(I)**2*GM(I)*Q(I))/GM(I)       TAY 0680
                 DO 1001 I = 2,10,2                                            TAY 0690
                 T(I) = T(I) + TD(I)*DX + (TDD(I)*DX**2)/2.                    TAY 0700
           1001  TD(I) = TD(I) + TDD(I)*DX                                     TAY 0710
                 DO 1002 I=1,NFM                                               TAY 0720
                 Q(I)=Q(I)+QD(I)*DX+(QDD(I)*DX**2)/2.                          TAY 0730
           1002  QD(I)=QD(I)+QDD(I)*DX                                         TAY 0740
                 RETURN                                                        TAY 0750
                 END                                                           TAY 0760
```

```
      SUBROUTINE IC   ZCGI,ZMI,ZNI,THETAI)                          ICE 0010
      COMMON/FLEX1/SIMAIN(15),SINOSE(15),SICG(15),SITAIL(15),SIPS(15) ICE 0020
      COMMON/FLEX2/NFM,GR(15),OMEGA(15)                             ICE 0030
      COMMON/FLEX3/Q(15),QD(15),QDD(15)                             ICE 0040
      COMMON/K1/W,MM,MN,MCG,MM,MN,A,B,MMI                           ICE 0050
      COMMON/K2/PAOM,VOM,AAM,AHM,OAM                                ICE 0060
      COMMON/K3/PAON,VON,AAN,AHN,OAN                                ICE 0070
      COMMON/K4/SKM,SKN,SLM,SLN,TSM ,TSN                            ICE 0080
      COMMON/K5/FSM,FSN,FTM,FTN,XMAIN,XNOSE,VBLM,VBLN               ICE 0090
C*******************************************************************ICE 0100
C THIS PROGRAM WILL FIND THE INITIAL CONDITIONS FOR  TAXI           ICE 0110
C  FOR SKM MAIN AND SKN NOSE GEAR                                   ICE 0120
C  ZMI= MAIN GEAR TIRE DEFLECTION 35 PERCENT                        ICE 0130
C  ZNI= NOSE GEAR TIRE DEFLECTION 35 PERCENT DEFLECTION             ICE 0140
C  ZCGI= CG DEFLECTION                                              ICE 0150
C  THETAI= PITCH ANGLE                                              ICE 0160
C  XMAIN=  MAIN LANDING GEAR STATIC STROKE                          ICE 0170
C  XNOSE=  NOSE GEAR STATIC STROKE                                  ICE 0180
C*******************************************************************ICE 0190
      RM=W/(1.+A/B)                                                 ICE 0200
      RN=W-RM                                                       ICE 0210
      RM=RM/SKM                                                     ICE 0220
      RN=RN/SKN                                                     ICE 0230
      ZMI=-RM/TSM                                                   ICE 0240
      ZNI=-RN/TSN                                                   ICE 0250
      RSM=RM-WM                                                     ICE 0260
      RSN=RN-WN                                                     ICE 0270
      XNOSE=-PAON*VON/RSN-VON/AAN                                   ICE 0280
      XMAIN=-PAOM*VOM/RSM-VOM/AAM                                   ICE 0290
      THETAI=-(XNOSE+ZNI-(XMAIN+ZMI))/(B+A)                         ICE 0300
      ZCGI=XMAIN-A*THETAI+ZMI                                       ICE 0310
       DO 10 I=1,NFM                                                ICE 0320
       QD(I)=0.                                                     ICE 0330
 10    Q(I)=0.                                                      ICE 0340
      RETURN                                                        ICE 0350
      END                                                           ICE 0360
```

```
SUBROUTINE COEFF       74/74    OPT=1                          FTN 4.2+P380        05/13/75  17.47.51.        PAGE      1

                 SUBROUTINE COEFF (Y,  A,B,C,D)                                          COEF0010
                 DIMENSION Y(4)                                                          COEF0020
                 A=Y(2)                                                                  COEF0030
                 B=Y(1)                                                                  COEF0040
                 C=(96.*Y(1)+56.*Y(2)-64.*Y(3)+8.*Y(4))/(-120.)                          COEF0050
                 D=(-16.*Y(1)-12.*Y(2)+16.*Y(3)-4.*Y(4))/(-120.)                         COEF0060
                 RETURN                                                                  COEF0070
                 END                                                                     COEF0080
```

```
      SUBROUTINE TLOOK (X,SLOPE,YCEPT,S,P,N)                  TL 0010
      DIMENSION S(30),P(30)                                   TL 0020
C                                                             TL 0030
C     THIS IS A 2 DIMENSIONAL TABLE LOOK UP ROUTINE           TL 0040
C     WITH LINEAR INTERPOLATION                               TL 0050
C                                                             TL 0060
C   X  IS THE CURRENT VALUE OF STROKE                         TL 0070
C   SLOPE AND YCEPT ARE CALCULATED AND RETURNED               TL 0080
C   S AND P  MAKE UP THE TABLE                                TL 0090
C   N IS THE NUMBER OF VALUES IN THE TABLE                    TL 0100
      DO 1 I=1,N                                              TL 0110
      IF (X.GE.S(I).AND.X.LT.S(I+1))GO TO 2                   TL 0120
    1  CONTINUE                                               TL 0130
    2 SLOPE=(P(I+1)-P(I))/(S(I+1)-S(I)+.01)                   TL 0140
      YCEPT=P(I)-SLOPE*S(I)                                   TL 0150
      RETURN                                                  TL 0160
      END                                                     TL 0170
```

```
SUBROUTINE PLQQQ      74/74   OPT=1                        FTN 4.2+P380      05/13/75  17.47.56.       PAGE     1

          SUBROUTINE PLQQQ(AA,BB)                                          PLTS0010
          CALL PLOT(0.,3.,-3)                                              PLTS0020
          RETURN                                                           PLTS0030
          END                                                              PLTS0040
```

APPENDIX B

COMPUTER LISTING OF "TAXI" USED TO SIMULATE CLASS E AIRCRAFT

```
      PROGRAM TAXI(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,PLOT,TAPE2,   TAXI0010
     1TAPE3)                                                           TAXI0020
*********************************************************************TAXI0030
*********************************************************************TAXI0040
*********************************************************************TAXI0050
                                                                       TAXI0060
C  THIS PROGRAM WILL PERFORM A SYMMETRIC                               TAXI0070
C  DYNAMIC TAXI ANALYSIS ON A FLEXIBLE                                 TAXI0080
C  VEHICLE TRAVERSING A GIVEN RIGID RUNWAY                             TAXI0090
C  PROFILE.                                                            TAXI0100
C        CLASS E AIRCRAFT                                              TAXI0110
C                                                                      TAXI0120
C                                                                      TAXI0130
*********************************************************************TAXI0140
*********************************************************************TAXI0150
*********************************************************************TAXI0160
      COMMON/FLEX1/SIMAIN(15),SINOSE(15),SIDE(15),STIAIL(15),SIPS(15)  TAXI0170
      COMMON/FLEX2/NFM,GM(15),OMEGA(15)                                TAXI0180
      COMMON/FLEX3/G(15),Q(15),QDOT(15)                                TAXI0190
      COMMON/X1/A,HM,HN,MCG,MM,MN,A,B,HME                              TAXI0200
      COMMON/X2/PAOM,VOM,AAM,AHM,OAM                                   TAXI0210
      COMMON/X3/PAON,VON,AAN,AHN,OAN                                   TAXI0220
      COMMON/X4/SAM,SAN,SCM,SCN,TSM ,TSN                               TAXI0230
      COMMON/X5/CL,CD,APLA,THRUST                                      TAXI0240
      COMMON/X6/Z,REACTM,REACTN,DX,NTRUN                               TAXI0250
      COMMON/X7/CM,JM,CM,JM,AN,GN,CN,JN                                TAXI0260
      COMMON/X8/STROKM(20),PINORM(20),STROKN(20),PINORN(20),NSOM,NSON  TAXI0270
      COMMON/X9/FLM,FSN,FIM,FIN,XMAIN,XNOSE,VELM,VELN                  TAXI0280
      COMMON/X10/ZPM,ZPN,X                                             TAXI0290
      COMMON/X11/ FFM,FFN                                              TAXI0300
      COMMON/X12/AL,BL,CK,UL,STROKRM(20),PINORM(20),NSORM,RLA,TRM,PAORM TAXI0310
       COMMON/X13/SIRMAIN(20),TURM,ZPRM,O,MMRM,OARM,AHRM,AARM,VORM      TAXI0320
       COMMON/X14/           FSRM,FTRM,XRMAIN,VELRM                    TAXI0330
      COMMON/U1/COM,SSM                                                TAXI0340
      DIMENSION PLANE(6),SITE(3)                                       TAXI0350
      DIMENSION T(12), TJ(12), TJJ(12)                                 TAXI0360
      DIMENSION ELEV(7000)                                             TAXI0370
      DIMENSION YP(4),YPN(4),DATA(400),YPR(8)                          TAXI0380
      DIMENSION GRADC(1800), TIME(1800), PSADC(1800), TIME1(1800)      TAXI0390
      DIMENSION PROF(1800),RMARK(20)                                   TAXI0400
      DIMENSION SSPLOT(300), STIME(300),DUPLOT(300)                    TAXI0410
      REAL MCG,MM,MN,MMI,MMRM                                          TAXI0420
      TSAR=0.                                                          TAXI0430
      LCOUT=0.0                                                        TAXI0440
      LUK=5                                                            TAXI0450
      MCP=0.                                                           TAXI0460
      X=0.                                                             TAXI0470
      LLL = 1                                                          TAXI0480
      LL = 1                                                           TAXI0490
      STORE1 = 0.                                                      TAXI0500
      STORE2 = 0.                                                      TAXI0510
      STORE3 = 0.                                                      TAXI0520
      STORE4 = 0.                                                      TAXI0530
      N = 1                                                            TAXI0540
      KK = 1                                                           TAXI0550
      KP = 1.0                                                         TAXI0560
      M = 1                                                            TAXI0570
      III = 1
```

[illegible]

```
****************************************  ****************************************
C        [illegible] INPUT DATA
**********************************************************************************
C   [illegible]
C   [illegible]
C   [illegible]
C   [illegible]
C   [illegible]
C   [illegible]
C   [illegible] STATION TO [illegible]
C   [illegible] TAIL STATION TO [illegible]
C   [illegible]
C   [illegible]
C   [illegible]
C   [illegible]
C   [illegible]
C   [illegible]
C   [illegible]
C   [illegible]
C   [illegible] OF EACH [illegible]
C   [illegible] MAIN GEAR STRUTS
C   [illegible] AUX. GEAR STRUTS
C [illegible] HYDRAULIC PISTON AREA [illegible] SQ INCHES
C [illegible] PNEUMATIC PISTON AREA [illegible] SQ INCHES
C   [illegible]
C   [illegible] PNEUMATIC PISTON AREA OF [illegible]
C [illegible] PNEUMATIC PISTON AREA MAIN SQ INCHES
C [illegible] PNEUMATIC PISTON AREA MAIN SQ INCHES
C [illegible] STRUT PRELOAD PRESSURE PSI
C [illegible] STRUT PRELOAD PRESSURE PSI
C   [illegible] PRESSURE OF [illegible]
C [illegible] STRUT INITIAL VOLUME CU. IN.
C [illegible] STRUT INITIAL VOLUME CU. IN.
C   [illegible] VOLUME OF [illegible]
C [illegible]
C [illegible]
C   [illegible]
C [illegible] STRUT LENGTH UNLOADED INCHES
C        [illegible] OF [illegible] TO [illegible] LINE
C [illegible] STRUT LENGTH UNLOADED INCHES
C        [illegible] OF [illegible] TO [illegible] LINE
C   [illegible] TIRE SPRING CONSTANT PER STRUT
C   [illegible] TIRE SPRING CONSTANT PER STRUT
C   [illegible] TIRE SPRING CONSTANT
C   [illegible]
C   [illegible] IF [illegible]
C   [illegible] IF [illegible]
C   [illegible] AT ZERO STROKE
C   [illegible] GEAR
C   [illegible] GEAR
C   [illegible] METERING PIN
C   [illegible] METERING PIN TABLES
C   [illegible]
C   [illegible]
C   [illegible]
C   [illegible]
C   [illegible]
```

```
    1   FORMAT(8A10)                                                      TAXI1150
        READ(5,5) W,A,B,C,MMI                                             TAXI1160
  5     FORMAT(4F10.2,F12.3)                                              TAXI1170
        READ(5,10) PSARM,TAILRM                                           TAXI1180
   10   FORMAT(2F10.2)                                                    TAXI1190
        READ(5,15) SPEED,THRUST,TAKOFF                                    TAXI1200
   15   FORMAT(3F10.3)                                                    TAXI1210
        READ(5,20) CL,AREA,CD                                             TAXI1220
   20   FORMAT(3F10.4)                                                    TAXI1230
        READ(5,25) WM,WN,SXM,SXN,WRM                                      TAXI1240
   25   FORMAT(5F10.2)                                                    TAXI1250
        READ(5,30) AHN,AAN,AHM,AAM,AHRM,AARM                              TAXI1260
   30   FORMAT(6F10.5)                                                    TAXI1270
        READ(5,35) PAON,PAOM,VON,VOM,OAM,OAN,PAORM,VORM                   TAXI1280
   35   FORMAT(8F10.5)                                                    TAXI1290
        READ(5,40) SLM,SLN                                                TAXI1300
   40   FORMAT(2F10.3)                                                    TAXI1310
        READ(5,45) TSM ,TSN,TSRM,OARM                                     TAXI1320
   45   FORMAT(4F10.1)                                                    TAXI1330
        READ(5,50)CX                                                      TAXI1340
        READ(5,51) IFPLOT,IFLIST                                          TAXI1350
   50   FORMAT(F10.3)                                                     TAXI1360
        READ(5,51) NSCN                                                   TAXI1370
   51   FORMAT(2I5)                                                       TAXI1380
        READ(5,52) (STROKN(I),PINDN(I),I=1,NSCN)                          TAXI1390
   52   FORMAT(2(F10.3))                                                  TAXI1400
        READ(5,51)NSCM                                                    TAXI1410
        READ(5,52) (STROKM(I),PINDM(I),I=1,NSCM)                          TAXI1420
        READ(5,51) NSCRM                                                  TAXI1430
        READ(5,52)(STROKRM(I),PINDRM(I),I=1,NSCRM)                        TAXI1440
        READ(5,51) NFM                                                    TAXI1450
        READ(5,53) (SIMAIN(I),SIRMAIN(I),SINOSE(I),SICG(I),SITAIL(I)      TAXI1460
       1,SIPS(I),I=1,NFM)                                                 TAXI1470
   53   FORMAT(6F10.7)                                                    TAXI1480
        READ(5,54) (OM(I),OMEGA(I),I=1,NFM)                               TAXI1490
   54   FORMAT(F10.3,F10.4)                                               TAXI1500
        RM=WM/386.                                                        TAXI1510
        RN=WN/386.                                                        TAXI1520
        RMRM=WRM/386.                                                     TAXI1530
        RCG=W/386.                                                        TAXI1540
        TYPRUN = .01                                                      TAXI1550
        IF(SPEED.GT.5.) TYPRUN = .02                                      TAXI1560
        DRUN=TYPRUN*100.                                                  TAXI1570
        WRITE(6,55)                                                       TAXI1580
   55   FORMAT(1H1,40X,*****************************************)        TAXI1590
        WRITE(6,60)                                                       TAXI1600
   60   FORMAT(46X,46H****************** INPUT DATA ****************)    TAXI1610
        WRITE(6,61)                                                       TAXI1620
   61   FORMAT(///1X,41H********* GENERAL AIRCRAFT DATA *********)        TAXI1630
        WRITE(6,62)PLANE                                                  TAXI1640
   62   FORMAT(//,1X,8A10)                                                TAXI1650
        WRITE(6,65) W,WM,WRM,WN,A,B,MMI                                   TAXI1660
   65   FORMAT(///,5X,*W=*,F10.1,5X,*WM=*,F10.2,5X,*WRM=*,F10.2,5X,       TAXI1670
       1*WN=*,F10.2,5X,*A=*,F10.3,5X,*B=*,F10.3,5X,*MMI=*,F12.0)          TAXI1680
        WRITE(6,66) SXM,SXN,SLM,SLN,PSARM,TAILRM,C                        TAXI1690
   66   FORMAT(//,5X,*SXM=*,F8.1,5X,*SXN=*,F9.1,5X,*SLM=*,F9.1,5X,        TAXI1700
       1*SLN=*,F8.1,5X,*PSARM=*,F7.1,4X,*TAILRM=*,F7.1,*C=*,F5.2)         TAXI1710
```

```
      WRITE(6,70) AAM,AMM,PAOM,VOM,OAM,TSM                             TAXI1720
 70   FORMAT(//,5X,*AAM=*,F8.2,5X,*AMM=*,F8.2,6X,*PAOM=*,F9.2,4X,      TAXI1730
     1*VOM=*,F8.2,5X,*OAM=*,F8.2,5X,*TSM =*,F10.2)                     TAXI1740
      WRITE(6,71) AARM,AMRM,PAORM,VORM,TSRM                            TAXI1750
 71   FORMAT(//,5X,*AARM=*,F10.2,5X,*AMRM=*,F10.2,5X,*PAORM=*,         TAXI1760
     1F10.2,5X,*VORM=*,F10.2,5X,*TSRM=*,F10.2)                         TAXI1770
      WRITE(6,74) AAN,AMN,PAON,VON,OAN,TSN                             TAXI1780
 74   FORMAT(//,5X,*AAN=*,F8.2,5X,*AMN=*,F8.2,6X,*PAON=*,F9.2,4X,      TAXI1790
     1*VON=*,F8.2,5X,*OAN=*,F8.2,5X,*TSN =*,F10.2)                     TAXI1800
      WRITE(6,75) CL,CD,AREA,SPEED,THRUST,TAKOFF                       TAXI1810
 75   FORMAT(//,5X,*CL=*,F9.3,5X,*CD=*,F9.3,6X,*AREA=*,F8.2,5X,        TAXI1820
     1*SPEED=*,F7.1,4X,*THRUST=*,F7.1,3X,*TAKOFF=*,F10.2)              TAXI1830
      WRITE(6,76) (STROKN(I),PINDN(I),I=1,NSCN)                        TAXI1840
 76   FORMAT(//,3X,*STROKE NOSE   PIN DIAMETER    *//,2(3X,F10.3))     TAXI1850
      WRITE(6,77) (STROKM(I),PINDM(I),I=1,NSCM)                        TAXI1860
 77   FORMAT(//,3X,*STROKE MAIN   PIN DIAMETER    *//,2(3X,F10.3))     TAXI1870
      WRITE(6,78)(STROKRM(I),PINDRM(I),I=1,NSCRM)                      TAXI1880
 78    FORMAT(//,3X,*STROK REAR MLG    PIN DIAMETER*,//,2(3X,F10.3))   TAXI1890
      WRITE(6,80)                                                      TAXI1900
 80   FORMAT(1H1,1X,*MODE  SIPS   SINOSE*,4X,*  SIGG   SIMAIN  SIRMAIN TAXI1910
     1SITAIL   OMEGA  GEN. PASS*)                                      TAXI1920
      DO 85  I=1,NFN                                                   TAXI1930
 85   WRITE(6,90 )(I,SIPS(I),SINOSE(I),SIGG(I),SIMAIN(I),SIRMAIN(I),   TAXI1940
     1SITAIL(I),OMEGA(I),GM(I))                                        TAXI1950
 90    FORMAT(//,     2X,I2,7(F7.2,2X),F10.1)                          TAXI1960
C ZMI =INITIAL MAIN GEAR POSITION INCHES                                TAXI1970
      WRITE(6,95)                                                      TAXI1980
 95   FORMAT(///,40X,*********** INITIAL CONDITIONS ************)      TAXI1990
C ZNI =INITIAL NOSE GEAR POSITION INCHES                                TAXI2000
C ZCGI=INITIAL C.G. POSITION INCHES                                     TAXI2010
C THETAI=INITIAL PITCH ANGLE DEGREES                                    TAXI2020
C   THE ABOVE PARAMETERS ARE CALCULATED IN SUBROUTINE IC                TAXI2030
      CALL IC(  ZCGI,ZMI,ZMIR,ZNI,THETAI)                              TAXI2040
      WRITE(6,105) ZMI,ZMIR,ZNI,THETAI,ZCGI                            TAXI2050
 105  FORMAT(//,5X,*ZMI=*,F10.3,5X,*ZMIR=*,F10.3,5X,*ZNI=*,F10.3,5X,   TAXI2060
     1*THETAI=*,F10.3,5X,*ZCGI=*,F10.3)                                TAXI2070
      REACTN=(ZNI*TSN )*SXN                                            TAXI2080
      REACTRM=(ZMIR*TSRM)*SXM                                          TAXI2090
      REACTM=(ZMI*TSM )*SXM                                            TAXI2100
      WRITE(6,106) XMAIN,XNOSE,REACTM,REACTN,REACTRM                   TAXI2110
 106  FORMAT (/,5X,*XMAIN=*,F8.3,5X,*XNOSE=*,F8.3,3X,*REACTM=*,F10.0,  TAXI2120
     15X,*REACTN=*,F10.0,5X,*REACTRM=*,F10.0)                          TAXI2130
      IF(IFPLOT.EQ.1) WRITE(6,107)                                     TAXI2140
 107  FORMAT(//*$$$$$ NO PLOT REQUESTED $$$$*)                         TAXI2150
***********************************************************************TAXI2160
C READ RUNWAY PROFILE DATA (ELEV)                                       TAXI2170
C   TITLE RUNWAY PROFILE AND DIRECTION                                  TAXI2180
C   NPTS=# OF RUNWAY ELEVATION DATA POINTS                              TAXI2190
      WRITE (6,111)                                                    TAXI2200
 111  FORMAT(*1*)                                                      TAXI2210
      DO 112 I=1,50                                                    TAXI2220
 112  ELEV(I)=0.0                                                      TAXI2230
      READ(5,1) SIT.                                                   TAXI2240
      READ(5,113) NPTS                                                 TAXI2250
      NPTS=NPTS+1                                                      TAXI2260
 113  FORMAT(I6)                                                       TAXI2270
      L=0                                                              TAXI2280
```

```
  117 LSO = LO + 9                                                  TAXI2290
      READ(2,118) (ELEV(I),I=LO,LSO)                                TAXI2300
  118 FORMAT(10F7.3)                                                TAXI2310
      N10=LO                                                        TAXI2320
      IF(LSO.GE.NFTSS) GO TO 120                                    TAXI2330
      LO=LO+10                                                      TAXI2340
      GO TO 117                                                     TAXI2350
  12  ELEV1=ELEV(51)                                                TAXI2360
      DO 125 I=51,N10                                               TAXI2370
  125 ELEV(I) = (ELEV(I)-ELEV1)*12.                                 TAXI2380
      DISTAN=0.                                                     TAXI2390
      LSD=LSO-5.                                                    TAXI2400
      SLP=(LSO-50)*2                                                TAXI2410
      SLP=ELEV(LSO)/SLP                                             TAXI2420
      DO 100 I=51 ,N10                                              TAXI2430
      ELEV(I)=ELEV(I)-SLP*DISTAN                                    TAXI2440
  10  DISTAN=DISTAN+2.                                              TAXI2450
      IVAL=(C+B)/24.                                                TAXI2460
      IWVAL=(C-A)/24.                                               TAXI2470
      WRITE(6,130)                                                  TAXI2480
  13. FORMAT(1H1,5X,*  RUNWAY PROFILE DATA NORMALIZED (SLOPE REMOVED)* TAXI2490
     150X,*FEET DOWN THE RUNWAY*)                                   TAXI2500
      WRITE(6,1) SITE                                               TAXI2510
      LO1=1                                                         TAXI2520
  135 LSO1 = LO1 + 9                                                TAXI2530
      LPRIN = LSO1 * 2                                              TAXI2540
      WRITE(6,140) (ELEV(I),I=LO1,LSO1),LPRIN                       TAXI2550
  14' FORMAT(3X,10F10.5,10X,I8)                                     TAXI2560
      LO1=LO1+10                                                    TAXI2570
      IF(LO1.GE.N10) GO TO 145                                      TAXI2580
      GO TO 135                                                     TAXI2590
  145 WRITE(6,150) LO1                                              TAXI2600
  15. FORMAT(42H********** END RUNWAY DATA ********** LO1=,I5)      TAXI2610
      ENDRUN = NFTSS*2                                              TAXI2620
      MRM=(ENDRUN-100.)/1000.                                       TAXI2630
      RM=(((ENDRUN-100.)-FLOAT(MRM*1000))/2.)+1100.                 TAXI2640
      WRITE(6,155)                                                  TAXI2650
      ENDRUN=ENDRUN-120.                                            TAXI2660
      T(2) =ZCGI                                                    TAXI2670
      TD(2) = 0.                                                    TAXI2680
      T(4) = ZMI                                                    TAXI2690
      TD(4) = 0.                                                    TAXI2700
      T(6) = ZNI                                                    TAXI2710
      TD(6) = 0.                                                    TAXI2720
      T(8) = THETAI                                                 TAXI2730
      TD(8) = 0.                                                    TAXI2740
      T(10) = 0.                                                    TAXI2750
      TD(10) = SPEED                                                TAXI2760
       T(12)=ZMIR                                                   TAXI2770
       TD(12)=0.                                                    TAXI2780
  155  FORMAT(1H1,7X,*   XMAIN      XNOSE        FSM           FSN  TAXI2810
     1   FSRM          SPEED      DIST.       CGACC          PSA     TIMTAXI2820
     2E*)                                                           TAXI2830
      DZ=0.                                                         TAXI2840
      ZPM=0.                                                        TAXI2850
      ZPN=0.                                                        TAXI2860
       ZPMR=0.                                                      TAXI2870
```

```
      ZDOT=0.                                                           TAXI2880
      ZNDOT=0.                                                          TAXI2890
      ZRDOT=0.                                                          TAXI2900
      J=1                                                               TAXI2910
 160  YP(1) = ZDOT                                                      TAXI2920
      YP(2)=ELEV(IRVAL)                                                 TAXI2930
      YP(3)=ELEV(IRVAL+1)                                               TAXI2940
      YP(4)=ELEV(IRVAL+2)                                               TAXI2950
      YPN(1)=ZNDOT                                                      TAXI2960
      YPN(2)=ELEV(IVAL)                                                 TAXI2970
      YPN(3)=ELEV(IVAL+1)                                               TAXI2980
      YPN(4)=ELEV(IVAL+2)                                               TAXI2990
      YPR(1)=ZRDOT                                                      TAXI3000
      YPR(2)=ELEV(J)                                                    TAXI3010
      YPR(3)=ELEV(J+1)                                                  TAXI3020
      YPR(4)=ELEV(J+2)                                                  TAXI3030
      Z=DZ                                                              TAXI3040
      CALL COEFF (YPN,AN,BN,CN,DN)                                      TAXI3050
      CALL COEFF (YP,AM,BM,CM,DM)                                       TAXI3060
       CALL COEFF(YPR,AL,BL,CK,DL)                                      TAXI3070
      ZDOT=BM                                                           TAXI3080
      ZNDOT=BN                                                          TAXI3090
       ZRDOT=BL                                                         TAXI3100
      IF(M.GT.1) GO TO 245                                              TAXI3110
      M = M + 1                                                         TAXI3120
 165  IF(IFLIST.EQ.1)  GO TO 166                                        TAXI3130
        WRITE(6,170) XMAIN,XNOSE,FSM,FSN,FSRM  ,TD(10),T(10),           TAXI3140
     1CGOUT ,PSA,X                                                      TAXI3150
 166  CONTINUE                                                          TAXI3160
 170   FORMAT(3X,2(3X,F10.3),3(3X,F10.0),4(3X,F10.3),2X,F7.3)           TAXI3170
      TIMEX=0.                                                          TAXI3180
************************************************************************TAXI3190
      IF(IFPLOT.EQ.1) GO TO 230                                         TAXI3200
      IF(ABS(CGOUT ).LE.ABS(STORE2).AND.ABS(STORE2).GE.ABS(STORE1))     TAXI3210
     1GO TO 180                                                         TAXI3220
 175  STORE1 = STORE2                                                   TAXI3230
      STORE2 = CGOUT                                                    TAXI3240
      GO TO 190                                                         TAXI3250
 180  IF(X-TIME(NN).GT..80) GO TO 185                                   TAXI3260
      IF(ABS(STORE2).GT..3G LOL) GO TO 185                              TAXI3270
      GO TO 175                                                         TAXI3280
 185  NN = NN + 1                                                       TAXI3290
      CGACC(NN) = STORE2                                                TAXI3300
      PROF(NN) = ZPM                                                    TAXI3310
      TIME(NN) = X - 10. * DX                                           TAXI3320
      IF(TIME(NN).LT.0.) TIME(NN) = .01                                 TAXI3330
      STORE1 = STORE2                                                   TAXI3340
      STORE2 = CGOUT                                                    TAXI3350
 190  IF(ABS(PSA).LE.ABS(STORE4).AND.ABS(STORE4).GE.ABS(STORE3))        TAXI3360
     1GO TO 205                                                         TAXI3370
 200  STORE3 = STORE4                                                   TAXI3380
      STORE4 = PSA                                                      TAXI3390
      GO TO 215                                                         TAXI3400
 205  IF(X-TIME1(LL).GT..30) GO TO 210                                  TAXI3410
      IF(ABS(STORE4).GT..32) GO TO 210                                  TAXI3420
      GO TO 200                                                         TAXI3430
 210  LL = LL + 1                                                       TAXI3440
```

```
      WMOD(LLL) = STORW                                                    TAXI3450
      TIMEI(LLL)** = 1.*3X                                                 TAXI3460
      IF(TIMEI(LLL).LE.(.) TIMEI(LLL) = .001                               TAXI3470
      STORM.. = STORM.                                                     TAXI3480
      ITCM.. = FSA                                                         TAXI3490
   41 IF(ABS(T(I,J)-MM).LT.E.E) GO TO 2..                                  TAXI3500
      GO TO 225                                                            TAXI3510
   42 II = II + 1                                                          TAXI3520
      .ARR(II) = 475.                                                      TAXI3530
      MM = MM + 1..                                                        TAXI3540
      III = II                                                             TAXI3550
  2.. IF(NUM.L...C..) GO TO 235                                            TAXI3560
      N = ..                                                               TAXI3570
      IF(IF..ST.....1)  GO T. 2..                                          TAXI3575
      . IT.(N,135)                                                         TAXI3580
  2.. C.NT.NU.                                                             TAXI3585
      . . . = ... + 1.                                                     TAXI3590
  2.. X = X + .X                                                           TAXI3600
      IF(ABS(X-PP).GT...339) GO TO 23.                                     TAXI3610
      ....O(LLL) = T..(I)                                                  TAXI3620
      ST..(LLL) = 475.                                                     TAXI3630
      ..F.OT(LLL) = T(I.)                                                  TAXI3640
      LLL = LLL + 1                                                        TAXI3650
      .. = PP + 5..                                                        TAXI3660
  23. CONTINUE                                                             TAXI3670
      CALL TAFL..(I,10,100)                                                TAXI3680
      IF(T(I,J)......ROUND GO TO 2..                                       TAXI3690
      IF(A.........) GO TO 245                                             TAXI3700
      .I...TI..X+.X                                                        TAXI3710
      ... I...                                                             TAXI3720
      ....=..                                                              TAXI3730
      C..T..=..                                                            TAXI3740
      ... I=I,.M                                                           TAXI3750
      ... TA..A...T..(...(I)*SIT..(I)                                      TAXI3760
      ......U..+...(I)*SIC.(I)                                             TAXI3770
  2..   ........(I)*SI..(I)                                                TAXI3780
      TAI..A..(I,J(2)+TAI.RM*TOJ(6))/3.6. +QODTAL/336.                     TAXI3790
      ....(J.(2)-P.ARM*TO.(6))/3.6.        +QODP./336.                     TAXI3800
      ...T+TO..(.)/3..     +G..../3.6.                                     TAXI3810
      IF(T.(I,J).G...TAKOFF) GO TO 25.                                     TAXI3820
      IF(Z..I...) GO TO 2..                                                TAXI3830
      Z=Z-..                                                               TAXI3840
      ....                                                                 TAXI3850
      I..=.A.L+2                                                           TAXI3860
      I..=I..L+2                                                           TAXI3870
      . T. 2..                                                             TAXI3880
  24. IF(TI.....LT..L.T. ) GO TO 24.                                       TAXI3890
      ...T....                                                             TAXI3900
      GO T. 1..                                                            TAXI3910
  25  ...T.(6,25.)                                                         TAXI3920
  25. F.RMAT(5X,* THE VEHICLE HAS TAKEN OFF*)                              TAXI3930
  2.. FORMAT(///,2(5X,F1..3),////)                                         TAXI3940
  2.. ..I. (6,2..) .ROUND,I(1 )                                            TAXI3950
  2.. F.RMAT(5X,* ... .F FORMAT*,2F1..3)                                   TAXI3960
***********************************************************************TAXI3970
      W..T (6,...)(...(I),...(I),STIME(I),I=1,...)                         TAXI3980
  2.. ... X                                                                TAXI39..
```

```
          PSRMS=0.                                                  TAXI4000
          CGRMS=0.                                                  TAXI4010
          DO 261 I=1,NN                                             TAXI4020
    261   CGRMS=CGRMS+CGACC(I)**2                                   TAXI4030
          DO 264 I=1,LL                                             TAXI4040
    264   PSRMS=PSRMS+PSACC(I)**2                                   TAXI4050
          PSRMS=100.*SQRT(PSRMS)/FLOAT(LL)                          TAXI4060
          CGRMS=100.*SQRT(CGRMS)/FLOAT(NN)                          TAXI4070
          WRITE(6,268) PSRMS,CGRMS                                  TAXI4080
    268    FORMAT(///,3X,*100 PSRMS=*,F10.3,10X,*100 CGRMS=*,F10.3) TAXI4090
          IF(IFPLOT.EQ.1) GO TO 283                                 TAXI4100
          XLONG = FLOAT(NGM)/5.                                     TAXI4110
          WRITE(6,265) NN,LL                                        TAXI4120
    265   FORMAT(2I20)                                              TAXI4130
          IF(NN.LE.1000.OR.LL.LE.1000) GO TO 266                    TAXI4140
          WRITE(6,267)                                              TAXI4150
    267   FORMAT(3X,*THE ARRAYS CGACC OR PSACC OR PROF HAVE EXCEEDED TAXI4160
         1 THEIR DIMENSIONED SIZE*)                                 TAXI4170
    266   CALL PLOTS(DATA,430)                                      TAXI4180
          CALL FACTOR (2.0)                                         TAXI4190
          CALL PLOT(0.0,-11.0,-3)                                   TAXI4200
          CALL PLOT(3.,.7,-3)                                       TAXI4210
          TIME(NN+1) = 0.0                                          TAXI4220
          TIME(NN+2) = 5.0                                          TAXI4230
          TIME1(LL+1)  =0.0                                         TAXI4240
          TIME1(LL+2) = 5.0                                         TAXI4250
          CGACC(NN+1) = -1.0                                        TAXI4260
          CGACC(NN+2) = 1.0                                         TAXI4270
          PSACC(LL+1)= -1.0                                         TAXI4280
          PSACC(LL+2) = 1.0                                         TAXI4290
          CALL SCALE(PROF,10.,NN,1)                                 TAXI4300
          PROF10 = PROF(NN+2) *10.                                  TAXI4310
          IF(PROF10.GT.10.5) GO TO 273                              TAXI4320
          PROF(NN+2) = 6.0                                          TAXI4330
          IF(NPTSS.GE.1000) GO TO 270                               TAXI4340
          DO 269 I=1,NN                                             TAXI4350
    269   PROF(I)=PROF(I)+36.                                       TAXI4360
    270   CALL AXIS(0.,0.,11HTIME (SEC.),-11,XLONG,0.0,TIME(NN+1),  TAXI4370
         1TIME(NN+2))                                               TAXI4380
          IXLONG = XLONG                                            TAXI4390
          CALL PLOT (XLONG,1.1,3)                                   TAXI4400
          CALL PLOT (0.,1.1,2)                                      TAXI4410
          CALL SYMBOL (.1,.4,.105,3HDISTANCE,0.,8)                  TAXI4420
          CALL SYMBOL (.1,.2,.105,5HSPEED,0.,5)                     TAXI4430
          DO 275  I=1,IXLONG                                        TAXI4440
          CALL NUMBER(STIME(I),.2,.105,SSPLOT(I),0.0,-1)            TAXI4450
    275   CALL NUMBER(STIME(I),.4,.105,DSPLOT(I),0.0,-1)            TAXI4460
          CALL PLOT (XLONG,1.5,3)                                   TAXI4470
          CALL PLOT (0.,1.5,2)                                      TAXI4480
          DO 280 I=1,ITT                                            TAXI4490
    280   CALL SYMBOL(XMARK(I),-.1,.245,14,0.0,1)                   TAXI4500
          CALL PLOT (XLONG,1.9,3)                                   TAXI4510
          CALL PLOT (0.,1.9,2)                                      TAXI4520
          CALL SYMBOL(0.,9.,.14,PLANE,0.,40)                        TAXI4530
          CALL SYMBOL(0.,8.,.14,SITE,0.,40)                         TAXI4540
          CALL SYMBOL(4.,7.,.14,10H100*CGRMS=,0.,10)                TAXI4550
          CALL SYMBOL(4.,6.5,.14,10H100*PSRMS=,0.,10)               TAXI4560
```

```
      CALL NUMBER(9.5,7.,.14,CGRMS,0.,1)                             TAXI4570
      CALL NUMBER(5.5,6.5,.14,PSRMS,0.,1)                            TAXI4580
      XLONG2=XLONG/2.                                                TAXI4590
      CALL SYMBOL(XLONG2,8.5,.14,11HAFFDL -FYS-,0.,11)               TAXI4600
      CALL SYMBOL(XLONG2,7.5,.14,10HWPAFB OHIO,0.,10)                TAXI4610
      CALL PLOT(0.,1.5,-3)                                           TAXI4620
      CALL AXIS(0.,-1.,3HCGA,3,2.0,90.,CGACC(NN+1),CGACC(NN+2))      TAXI4630
      CALL NUMBER(0.4,-.4,.105,-.4,00.0,1)                           TAXI4640
      CALL NUMBER(0.5,.4,.105,+.4,00.0,1)                            TAXI4650
      CALL PLOT(0.,-1.0,-3)                                          TAXI4660
      CALL LINE(TIME,CGACC,NN,1,0,74)                                TAXI4670
      CALL PLOT (XLONG,0.1,3)                                        TAXI4680
      CALL PLOT (0.,3.1,2)                                           TAXI4690
      CALL PLOT(0.,3.5,-3)                                           TAXI4700
      CALL AXIS(0.,-1.,3HPSA,3,2.0,90.,PSACC(LL+1),PSACC(LL+2))      TAXI4710
      CALL PLOT(0.,0.,3)                                             TAXI4720
      CALL PLOT(XLONG,0.,2)                                          TAXI4730
      CALL PLOT (XLONG,.4,3)                                         TAXI4740
      CALL PLOT (-.1,.4,2)                                           TAXI4750
      CALL NUMBER(0.5,.4,.105,+.4,00.0,1)                            TAXI4760
      CALL NUMBER(0.4,-.5,.105,-.4,00.0,1)                           TAXI4770
      CALL PLOT(0.,-1.0,-3)                                          TAXI4780
      CALL LINE(TIME1,PSACC,LL,1,0,74)                               TAXI4790
      CALL PLOT(0.,-3.0,-3)                                          TAXI4800
      CALL AXIS(-1.,0.,19HELEVATION (IN.),19,10.0,90.,0.,PROF(NN+1), TAXI4810
     1PROF(NN+2))                                                    TAXI4820
      CALL PLOT(0.,0.,-3)                                            TAXI4830
      XPROF=.25+ABS(PROF(NN+1))/PROF(NN+2)                           TAXI4840
      CALL SYMBOL (2.,XPROF,.14,15HNOSE GEAR TRACK,0.,15)            TAXI4850
      CALL LINE(TIME,PROF,NN,1,0,74)                                 TAXI4860
      XSTOP=XLONG+5.                                                 TAXI4870
      CALL PLOT (XSTOP,0.,-3)                                        TAXI4880
      WRITE(6,290)                                                   TAXI4890
      CALL PLOTE                                                     TAXI4900
  285 STOP                                                           TAXI4910
  290 FORMAT(*S*)                                                    TAXI4920
      END                                                            TAXI4930
```

```
      SUBROUTINE TAYLOR(T,TD,TDD)
      COMMON/FLEX1/SIMAIN(15),SINOSE(15),SIGG(15),SITAIL(15),SIPS(15)
      COMMON/FLEX2/NFM,GM(15),OMEGA(15)
      COMMON/FLEX3/Q(15),QD(15),QDD(15)
      COMMON/X1/W,WM,WN,MGG,MM,MN,A,B,AMI
      COMMON/X2/FAOM,VOM,AAM,AHM,OAM
      COMMON/X3/FAON,VON,AAN,AHN,OAN
      COMMON/X4/SXM,SXN,SLM,SLN,TSM ,TSN
      COMMON/X5/CL,CD,AREA,THRUST
      COMMON/X6/Z,REACTM,REACTN,DX,HTRJN
      COMMON/X7/AM,BM,CM,DM,AN,BN,CN,DN
      COMMON/X8/STROKM(20),PINDM(20),STROKN(20),PINDN(20),NSDM,NSDN
      COMMON/X9/FSM,FSN,FTM,FTN,XMAIN,XNOSE,VELM,VELN
      COMMON/X10/ZPM,ZPN,X
      COMMON/X12/AL,BL,CK,DL,STROKRM(20),PINDRM(20),NSDRM,REACTRM,PAORM
       COMMON/X13/SIRMAIN(20),TSRM,ZPMR,C,MMRM,OARM,AHRM,AARM,VORM
       COMMON/X14/          FSRM,FTRM,XRMAIN,VELRM
      COMMON/G1/COM,SSM
      DIMENSION T(12), TD(12), TDD(12)
      REAL MGG,MM,MN,MMI,MMRM
       CL=.615
      CD=.035
       AREA=5563.
    1 Z=Z+TD(10)*DX+TDD(10)*DX**2/2.
   12 ZPM=AM+BM*Z+CM*Z**2+DM*Z**3
      ZPN=AN+BN*Z+CN*Z**2+DN*Z**3
       ZPMR=AL+BL*Z+CK*Z**2+DL*Z**3
       QTN=0.
      QTM=0.
      QTOMR=0.
       QTMR=0.
      QTON=0.
       QTOM=0.
       DO 13  I=1,NFM
       QTN=QTN+Q(I)*SINOSE(I)
      QTM=QTM+Q(I)*SIMAIN(I)
       QTMR=QTMR+Q(I)*SIRMAIN(I)
       QTOM=QTOM+QD(I)*SIMAIN(I)
       QTOMR=QTOMR+QD(I)*SIRMAIN(I)
    3 FORMAT(6F12.2)
   13  QTON=QTON+QD(I)*SINOSE(I)
      XNOSE = (T(2) - B * T(8) - T(6)) +QTN
      XMAIN = (T(2) + A * T(8) - T(4)) +QTM
       XRMAIN=(T(2)+C*T(8)-T(12))+QTMR
      VELM = TD(2) + A * TD(8) - TD(4) +QTOM
       VELRM=(TD(2)+C*TD(8)-TD(12))+QTOMR
      VELN = TD(2) - B * TD(8) - TD(6) +QTON
       IF(XRMAIN.GE.0.) XRMAIN=-.1
      IF(XNOSE.GE.0.) XNOSE=-.1
      IF(VELM.EQ.0.) VELM=-.1
      IF(VELRM.EQ.0.) VELRM=-.1
      IF(VELN.EQ.0.) VELN=-.1
      XMLK=ABS(XMAIN)
      XRMLK=ABS(XRMAIN)
      XNLK=ABS(XNOSE)
      SMM=VOM/AAM
      STRM=VORM/AARM
```

```
      SMN=VON/AAN                                                       TAY 0580
      IF(XMLK.GE.SMM) XMLK=SMM-.5                                       TAY 0590
      IF(XNLK.GE.SMN) XNLK=SMN-.5                                       TAY 0600
      IF(XRMLK.GE.STRM) XRMLK=STRM-.5                                   TAY 0610
C  NOSE AND MAIN DAMPING COEFF                                          TAY 0620
      CALL TLOOK(XMLK,SLOPEM,YCEPM,STROKM,PINOM,NSCM)                   TAY 0630
      CALL TLOOK(XNLK,SLOPEN,YCEPN,STROKN,PINON,NSCN)                   TAY 0640
       CALL TLOOK(XRMLK,SLOPERM,YCEPRM,STROKRM,PINORM,NSCRM)            TAY 0650
      AOM = OAM -ABS((SLOPEM*XMLK+YCEPM)**2)*.78539                     TAY 0660
      AORM=OARM-ABS((SLOPERM*XRMLK+YCEPRM)**2)*.78539                   TAY 0670
      AON = OAN -ABS((SLOPEN*XNLK+ YCEPN)**2)*.78539                    TAY 0680
      CON=(.00030*(AHN**3.))/(2.*(.9*AON)**2)                           TAY 0690
      COM=(.00030*(AHM**3.))/(2.*(.9*AOM)**2)                           TAY 0700
       CORM=(.00003*(AHRM**3.))/(2.*(.9*AORM)**2)                       TAY 0710
C  NOSE AND MAIN STRUT PNEUMATIC FORCES                                 TAY 0720
      SSM=(PAOM*VOM)/(((VOM/AAM)-XMLK))                                 TAY 0730
      SSRM=(PAORM*VORM)/(((VORM/AARM)-XRMLK))                           TAY 0740
      SSN=(PAON*VON)/(((VON/AAN)-XNLK))                                 TAY 0750
      FTM = SXM * TSM * (T(4) - ZPM)                                    TAY 0760
       FTRM=SXM*TSRM*(T(12)-ZPMR)                                       TAY 0770
      FTN =SXN* TSN * (T(6) - ZPN)                                      TAY 0780
      IF(FTM.GT.0.)FTM=0.                                               TAY 0790
       IF(FTRM.GT.0.) FTRM=0.                                           TAY 0800
      IF(FTN.GT.0.)FTN=0.                                               TAY 0810
      FSN=SXN*(-SSN+CON*VELN*ABS(VELN) )                                TAY 0820
      FSM=SXM*(-SSM    +COM *VELM*ABS(VELM) )                           TAY 0830
      FSRM=SXM*(-SSRM   +CORM*VELRM*ABS(VELRM))                         TAY 0840
      VLIFT =.001189*CL*AREA*(TD(10)*TD(10))                            TAY 0850
      DRAGA=VLIFT*CD/CL                                                 TAY 0860
      DRAGT=ABS(.025*(FTM+FTRM+FTN))                                    TAY 0870
      THRUST=(-29.6*TD(10)+43700.)*4.                                   TAY 0880
      IF(NTRUN.EQ.1) GO TO 125                                          TAY 0890
6     FORMAT(I5)                                                        TAY 0900
      THRUST=DRAGA+DRAGT                                                TAY 0910
125   TDD(2) = (-FSN-FSM-FSRM-MCG*386.+VLIFT)/MCG                       TAY 0920
      TDD(4)=(FSM-FTM-386.*SXM*MM)/(MM*SXM)                             TAY 0930
      TDD(6)=(FSN-FTN-MN*386.*SXN)/(MN*SXN)                             TAY 0940
      TDD(8) =-(FSM*A -FSN*B+FSRM*C -DRAGT *(SLM+XMAIN))/MMI            TAY 0950
      TDD(10) = (THRUST-DRAGA-DRAGT)/((MCG*12.))                        TAY 0960
      TDD(12)=(FSRM-FTRM-386.*SXM*MMRM)/(MMRM*SXM)                      TAY 0970
      DO 200 I=1,NFM                                                    TAY 0980
200    QDD(I)=-(SIMAIN(I)*(FSM-REACTM)+SINOSE(I)*(FSN-REACTN)           TAY 0990
     1+SIRMAIN(I)*(FSRM-REACTRM)                                        TAY 1000
     1+.10*OMEGA(I)*QD(I)*GM(I)+OMEGA(I)**2*GM(I)*Q(I))/GM(I)           TAY 1010
      DO 1001 I = 2,12,2                                                TAY 1020
      T(I) = T(I) + TD(I)*DX + (TDD(I)*DX**2)/2.                        TAY 1030
1001  TD(I) = TD(I) + TDD(I)*DX                                         TAY 1040
4     FORMAT(9F12.3)                                                    TAY 1050
      DO 1002 I=1,NFM                                                   TAY 1060
      Q(I)=Q(I)+QD(I)*DX+(QDD(I)*DX**2)/2.                              TAY 1070
1002  QD(I)=QD(I)+QDD(I)*DX                                             TAY 1080
      RETURN                                                            TAY 1090
      END                                                               TAY 1100
```

SUBROUTINE IC   74/74   OPT=1   FTN 4.2+P386   03/15/75 11.51.43.   PAGE   1

```
          SUBROUTINE IC( ZCG1,ZMI,ZMIR,ZNI,THETAI)                      ICE 0010
          COMMON/FLEX1/SIMAIN(15),SINOSE(15),SICG(15),SITAIL(15),SIPS(15)  ICE 0020
          COMMON/FLEX2/NFM,GM(15),OMEGA(15)                             ICE 0030
          COMMON/FLEX3/Q(15),QD(15),QDD(15)                             ICE 0040
          COMMON/X1/W,WM,WN,MCG,MM,MN,A,B,4MI                           ICE 0050
          COMMON/X2/PAOM,VOM,AAM,AMM,OAM                                ICE 0060
          COMMON/X3/PAON,VON,AAN,AMN,OAN                                ICE 0070
          COMMON/X4/SXM,SXN,SLM,SLN,TSM ,TSN                            ICE 0080
          COMMON/X9/FSM,FSN,FTM,FTN,XMAIN,XNOSE,VELM,VELN               ICE 0090
          COMMON/X12/AL,BL,CK,DL,STROKRM(20),PINDRM(20),NSCRM,REACTRM,PAORM ICE 0100
           COMMON/X13/SIRMAIN(20),TSRM,ZPMR,C,MMRM,OARM,AMRM,AARM,VORM  ICE 0110
           COMMON/X14/           FSRM,FTRM,XRMAIN,VELRM                 ICE 0120
*****************************************************************ICE 0130
C THIS PROGRAM WILL FIND THE INITIAL CONDITIONS FOR  TAXI              ICE 0140
C  FOR SXM MAIN AND SXN NOSE GEAR                                      ICE 0150
C  ZMI= MAIN GEAR TIRE DEFLECTION 35 PERCENT                           ICE 0160
C  CLASS E  INITIAL CONDITIONS                                         ICE 0170
C  ZNI= NOSE GEAR TIRE DEFLECTION 35 PERCENT DEFLECTION                ICE 0180
C  ZCGI= CG DEFLECTION                                                 ICE 0190
C  THETAI= PITCH ANGLE                                                 ICE 0200
C  XMAIN=  MAIN LANDING GEAR STATIC STROKE                             ICE 0210
C  XNOSE=  NOSE GEAR STATIC STROKE                                     ICE 0220
*****************************************************************ICE 0230
          RM=5000.                                                      ICE 0240
 1        RM=RM+50.                                                     ICE 0250
          RN=(RM*A+C*W-C*RM)/(B+C)                                      ICE 0260
          RRM=W-RN-RM                                                   ICE 0270
           RMT=RM/2.                                                    ICE 0280
           RRMT=RRM/2.                                                  ICE 0290
          ZMIR=+RRMT/(TSRM)                                             ICE 0300
          ZMI =RMT/TSM                                                  ICE 0310
          ZNI=+RN/TSN                                                   ICE 0320
          XRMAIN=PAORM*VORM/((RMT  )-VORM/AAM                           ICE 0330
          XMAIN=PAOM*VOM/(RMT  )-VOM/AAM                                ICE 0340
          XNOSE=PAON*VON/RN-VON/AAN                                     ICE 0350
          THETAI=-(XNOSE+ZNI-(XRMAIN+ZMIR))/(C+B)                       ICE 0360
          CP=-THETAI                                                    ICE 0370
          CCC=(-XMAIN+ZMI-(-XRMAIN+ZMIR))/(C-A)                         ICE 0380
           CC=ABS(ABS(CP)-ABS(CCC))                                     ICE 0390
           IF(CC.GT..0001  ) GO TO 1                                    ICE 0400
          ZNI=-ZNI                                                      ICE 0410
          ZMI=-ZMI                                                      ICE 0420
          ZMIR=-ZMIR                                                    ICE 0430
          ZCGI=XMAIN-A*THETAI+ZMI                                       ICE 0440
 10       WRITE(6,20)AN,RM,RRM,ZMI,ZMIR,ZNI,XRMAIN,XMAIN,               ICE 0450
         1XNOSE,THETAI,CP,CC                                            ICE 0460
 20       FORMAT(12(F9.1,1X))                                           ICE 0470
          RETURN                                                        ICE 0480
          END                                                           ICE 0490
```

```
      SUBROUTINE TLOOK (X,SLOPE,YCEPT,S,P,N)                      TL  0010
      DIMENSION S(33),P(33)                                       TL  0020
C                                                                 TL  0030
C     THIS IS A 2 DIMENSIONAL TABLE LOOK UP ROUTINE               TL  0040
C     WITH LINEAR INTERPOLATION                                   TL  0050
C                                                                 TL  0060
C   X  IS THE CURRENT VALUE OF STROKE                             TL  0070
C   SLOPE AND YCEPT ARE CALCULATED AND RETURNED                   TL  0080
C   S AND P  MAKE UP THE TABLE                                    TL  0090
C   N IS THE NUMBER OF VALUES IN THE TABLE                        TL  0100
      DO 1 I=1,N                                                  TL  0110
      IF (X.GE.S(I).AND.X.LT.S(I+1))GO TO 2                       TL  0120
    1  CONTINUE                                                   TL  0130
    2 SLOPE=(P(I+1)-P(I))/(S(I+1)-S(I)+.01)                       TL  0140
      YCEPT=P(I)-SLOPE*S(I)                                       TL  0150
      RETURN                                                      TL  0160
      END                                                         TL  0170
```

```
      SUBROUTINE COEFF (Y,  A,B,C,D)                                   COEF0010
      DIMENSION Y(4)                                                   COEF0020
      A=Y(2)                                                           COEF0030
      B=Y(1)                                                           COEF0040
      C=(40.*Y(1)+[illegible]*Y(2)-64.*Y(3)+8.*Y(4))/(-128.)           COEF0050
      D=(-16.*Y(1)-12.*Y(2)+16.*Y(3)-4.*Y(4))/(-128.)                  COEF0060
      RETURN                                                           COEF0070
      END                                                              COEF0080
```

```
      SUBROUTINE PLOD3(AA,BB)                                          PLTS0010
      CALL    CT(0.,0.,-3)                                             PLTS0020
      RET                                                              PLTS0030
      END                                                              PLTS0040
```

APPENDIX C

COMPUTER LISTING OF SUBROUTINE TAYLOR USED TO INCLUDE BEARING FRICTION IN THE STRUT FORCE

```
      SUBROUTINE TAYLOR(T,TD,TDD)                                      TAY 301
      COMMON/FL4E1/ZIMAIN(15),SINOS(15),SIGS(15),SITAIL(15),STOS(15)   TAY 302
      COMMON/FL X2/OFF,GM(15),OMEGA(15)                                TAY 303
      COMMON/FL X3/Z(15),ZD(15),ODD(15)                                TAY 304
      COMMON/X1/M,MM,AN,MCG,MN,HN,A,D,MMI                              TAY 305
      COMMON/X2/PAOM,VOM,AAM,AHM,OAM                                   TAY 306
      COMMON/X3/PAON,VON,AAN,AHN,OAN                                   TAY 307
      COMMON/X4/SKM,SKN,SLM,SLN,TSM ,TSN                               TAY 308
      COMMON/X5/CL,CD,AREA,THRUST                                      TAY 309
      COMMON/X6/Z,REACT,REACIN,DX,NTRUN                                TAY 310
      COMMON/X7/AM,BM,CM,DM,AN,BN,CN,DN                                TAY 311
      COMMON/X8/STROKM(2),PINOM(2),STROKN(2),PINON(2),NSCM,NSCN        TAY 312
      COMMON/X9/F,M,FSM,FTM,FIN,XMAIN,XNOSE,VLM,VELN                   TAY 313
      COMMON/X10/ZPM,ZPN                                               TAY 314
      COMMON/X11/FFM,FFN                                               TAY 315
      COMMON/X12/CDM,CDN                                               TAY 316
      DIMENSION T(12), TD(12), TDD(12)                                 TAY 317
      REAL MCG,MM,MN,MMI                                               TAY 318
      PHIN= .76.24                                                     TAY 319
      PLN=0.                                                           TAY 320
      DIN=1.                                                           TAY 321
      OFFN=1.                                                          TAY 322
      FFDN=.2/.                                                        TAY 323
      PHIM=..*3.14159/18..                                             TAY 324
      PLM=5.4                                                          TAY 325
      DIMAIN=.                                                         TAY 326
      OFFM=3.                                                          TAY 327
      FFDM=.215.                                                       TAY 328
    1 Z=Z+T(1)(1)*DX+TD(1)*DX**2/2.                                    TAY 329
   12 ZPM=AM+BM*Z+CM*Z**2+DM*Z**3                                      TAY 330
      ZPN=AN+BN*Z+CN*Z**2+DN*Z**3                                      TAY 331
        DIN=0.                                                         TAY 332
      DIM=0.                                                           TAY 333
      DIDN=0.                                                          TAY 334
        DIDM=0.                                                        TAY 335
       DO 13 I=1,NEM                                                   TAY 336
        DIN=DIN+D(I)*SINOS(I)                                          TAY 337
      DIM=DIM+D(I)*ZIMAIN(I)                                           TAY 338
        DIDM=DIDM+ZD(I)*ZIMAIN(I)                                      TAY 339
   13   DIDN=DIDN+ZD(I)*SINOS(I)                                       TAY 340
      XNOSE  = T(2) - N * T(3) - T(5) +DIN                             TAY 341
      VELN = T (2) - . * T(3) - TD(5) +DIDN                            TAY 342
      XMAIN = (T(1) + A * T(3) - T(4)) +DIM                            TAY 343
      VLM = TD(2) + A * TD(3) - TD(4) +DIDM                            TAY 344
      IF(XMAIN.GE.0.) XMAIN=0.                                         TAY 345
      IF(XNOSE.GE.0.) XNOSE=0.                                         TAY 346
      IF(VLM.GT.0.) VLM=0.                                             TAY 347
      IF(VLN.GT.0.) VLN=0.                                             TAY 348
      XMLK=ABS(XMAIN)                                                  TAY 349
      XNLK=ABS(XNOSE)                                                  TAY 350
C   NOSE AND MAIN DAMPING COEFF                                        TAY 351
      CALL TLOOK(XMLK,SLOPEM,YCEPM,[illegible])                        TAY 352
      CALL TLOOK(XNLK,SLOPEN,YCEPN,[illegible])                        TAY 353
      ADM = DAM +A*((SLOPEM*XMLK+YCEPM)**2)*.79[illegible]             TAY 354
      ADN = DAN +A*((SLOPEN*XNLK+YCEPN)**2)*.79[illegible]             TAY 355
      COM=(.02[illegible]*(AHM**3.))/(2.*(.3*ADM)**2)                  TAY 356
      COM=(.0[illegible]*(AHM**3.))/(2.*(.3*ADM)**2)                   TAY 357
```

```
C   NOSE AND MAIN STRUT PNEUMATIC FORCES                                 TAY 0580
      SSM=(PAOM*VOM)/(((VOM/AAM)-XMLK))                                  TAY 0590
      SSN=(PAON*VON)/(((VON/AAN)-XNLK))                                  TAY 0600
      FTM = SXM * TSM * (T(4) - ZPM)                                     TAY 0610
      FTN =SXN* TSN * (T(6) - ZPN)                                       TAY 0620
      IF(FTM.GT.0.)FTM=0.                                                TAY 0630
      IF(FTN.GT.0.)FTN=0.                                                TAY 0640
      FUN=(SIN(PHIN)+.225)*FTN*(-1+PLN/(BSN+XNLK))+FTN*(OFFN)/(BSN+XNLK) TAY 0650
      FUM=(SIN(PHIM)+.225)*FTM*(-1+PLM/(BSM+XMLK))+FTM*(OFFM)/(BSM+XMLK) TAY 0660
      FLN=(SIN(PHIN)+.225)*FTN*(PLN/(BSN+XNLK))+FTN*(OFFN)/(BSN+XNLK)    TAY 0670
      FLM=(SIN(PHIM)+.225)*FTM*(PLM/(BSM+XMLK))+FTM*(OFFM)/(BSM+XMLK)    TAY 0680
      FFM=(.15*ABS(FLM)+.15*ABS(FUM)+FFOM)*VELM/ABS(VELM)                TAY 0690
      FFN=(.15*ABS(FLN)+.15*ABS(FUN)+FFON)*VELN/ABS(VELN)                TAY 0700
      FSN=SXN*(-SSN+CON*VELN*ABS(VELN) )                                 TAY 0710
      FSM=SXM*(-SSM +COM*VELM*ABS(VELM) )                                TAY 0720
      FSM=FSM+FFM                                                        TAY 0730
      FSN=FSN+ FFN                                                       TAY 0740
      VLIFT =.00119)*CL*AREA*(TD(10)*TD(10))                             TAY 0750
      DRAGA=VLIFT*CD/CL                                                  TAY 0760
      DRAGT =ABS(.025*FTM+.025*FTN)                                      TAY 0770
      IF(NT.UN.EQ.1) GO TO 125                                           TAY 0780
      THRUST=DRAGA+DRAGT                                                 TAY 0790
  125 TDD(2) = (-FSN-FSM-MCG*386.+VLIFT)/MCG                             TAY 0800
      TDD(4)=(FSM-FTM-386.*SXM*MM)/(MM*SXM)                              TAY 0810
      TDD(6)=(FSN-FTN-MN*386.*SXN)/(MN*SXN)                              TAY 0820
      TDD(8) =-(FSM*A -FSN*B -DRAGT *(SLM+XMAIN))/MMI                    TAY 0830
      TDD(10) = (THRUST-DRAGA-DRAGT)/((MCG*12.))                         TAY 0840
      DO 200 I=1,NFM                                                     TAY 0850
  200  QDD(I)=-(SIMAIN(I)*(FSM-REACTM)+SINOSE(I)*(FSN-REACTN)            TAY 0860
     1+.1 *OMEGA(I)*QD(I)*GM(I)+OMEGA(I)**2*GM(I)*Q(I))/GM(I)            TAY 0870
      DO 1001 I = 2,10,2                                                 TAY 0880
      T(I) = T(I) + TD(I)*DX + (TDD(I)*DX**2)/2.                         TAY 0890
 1001 TD(I) = TD(I) + TDD(I)*DX                                          TAY 0900
      DO 1002 I=1,NFM                                                    TAY 0910
      Q(I)=Q(I)+QD(I)*DX+(QDD(I)*DX**2)/2.                               TAY 0920
 1002 QD(I)=QD(I)+QDD(I)*DX                                              TAY 0930
      RETURN                                                             TAY 0940
      END                                                                TAY 0950
```

APPENDIX D

FORTRAN SYMBOL DEFINITIONS

This appendix contains an alphabetical listing of the Fortran variables used in the program "TAXI" categorized by the subroutine in which they are defined. In cases where a variable is defined in two or more subroutines, it is listed under the subroutine in which it is used most often. Some symbols used in the Class E Aircraft computer code are not listed. These variables are those which have been formed by adding an R to a variable name which is contained in the basic "TAXI" computer code. The R refers to the rear set of main gear.

FORTRAN SYMBOL DEFINITIONS

TAXI

SYMBOL	DEFINITION
A	Distance from CG to front main gear
AAM	Pneumatic area, main gear
AAN	Pneumatic area, nose gear
AHM	Hydraulic area, main gear
AHN	Hydraulic area, nose gear
AM	Coefficient of polynomial fit to runway profile segment, rear main gear
AN	Coefficient of polynomial fit to runway profile segment, nose gear
AREA	Aircraft wing area
B	Distance from CG to nose gear
BM	Coefficient of polynomial fit to runway profile segment, rear main gear
BN	Coefficient of polynomial fit to runway profile segment, nose gear
C	Distance from CG to rear main gear (Class E simulation only)
CD	Coefficient of drag
CGACC	Array containing CG accelerations for Calcomp plot
CGOUT	Total CG acceleration
CL	Coefficient of lift
CM	Coefficient of polynomial fit to runway profile segment, rear main gear
CN	Coefficient of polynomial fit to runway profile segment, nose gear

SYMBOL	DEFINITION
DDPLOT	Array containing aircraft distance down the runway for Calcomp plot
DISTAN	Distance down the runway used in removing overall slope from runway profile
DM	Coefficient of polynomial fit to runway profile segment, rear main gear
DN	Coefficient of polynomial fit to runway profile segment, nose gear
DX	Time step for integration
DZ	Variable which compendates for the overlap of two adjacent runway segments
ELEV	Array containing runway profile elevations
ELEVI	Elevation of first runway profile point
ENDRUN	Length of runway
GM	Array containing generalized masses for each flexible mode of vibration
HDR	Counter for printing header on printed output
I	Index variable
IFPLOT	Variable which contains decision to produce plotted output or not
IFLIST	Variable which contains decision to produce a listed output or not
II	Subscript variable for runway markers on Calcomp plot
IVAL	Integer truncation of distance between nose and rear main gear
IRVAL	Integer truncation of distance between rear main gear and front main gear (Class E simulation only)
IXLONG	Integer truncation of length of time axis on Calcomp plot
J	Subscript variable for runway profile

Symbol	DEFINITION
LD	Counting variable for runway profile input
LD1	Counting variable for runway profile output listing
LL	Subscript variable for storage of pilot station acceleration time history
LLL	Subscript variable for storage of aircraft speed and distance for Calcomp plot
LPRIN	Runway distance for runway profile listing
LSD	Counting variable for runway profile input
LSD1	Counting variable for runway profile listing
M	Counting variable for printing out output header first time
MCG	Mass of entire aircraft
MGM	Integer truncation of total simulation time
MM	Mass of unsprung portion of one main landing gear
MMI	Pitching moment of inertia about aircraft center of gravity
MN	Mass of the unsprung portion of the nose landing gear
MRM	Length of runway divided by 1000 feet
MFM	Number of flexible modes
NN	Subscript variable for CG acceleration time history
NPTSS	Number of runway profile points
NSCM	Number of slope or area changes on main strut metering pin
NSCN	Number of slope or area changes on nose strut metering pin
NTRUN	Defines run as taxi or takeoff
N10	Index variable for normalization of runway profile
OAM	Area of orifice hole, main gear
OAN	Area of orifice hole, nose gear

SYMBOL	DEFINITION
OMEGA	Array of flexible mode frequencies
PAOM	Preload pressure of main gear strut
PAON	Preload pressure of nose gear strut
PINDM	Array containing main gear metering pin diameters for conventional aircraft and net orifice areas for aircraft with metering tubes or flutted metering pins
PINDN	Array containing nose gear metering pin diameters for conventional aircraft and net orifice areas for aircraft with metering tubes or flutted metering pins
PLANE	Aircraft being simulated
PP	Counting variable for storage of distance and speed for Calcomp plot
PROF	Runway profile time history elevations
PROF10	PROF (NN+2)X10
PSA	Pilot station acceleration
PSACC	Array containing pilot station acceleration time history
PSARM	Distance from pilot station to CG
Q	Array of non-dimensional time dependent coordinates which weight the amount of motion due to each flexible mode in the total motion of the aircraft
QD	Time derivative of Q
QDD	Time derivative of QD
QDDCG	CG acceleration due to flexible motion
QDDPS	Pilot station acceleration due to flexible motion
QDDTAL	Tail station acceleration due to flexible motion
REACTM	Static, total force at main gear
REACTN	Static, total force at nose gear
RM	Incremented variable for determining position of runwav markers

SYMBOL	DEFINITION
RMARK	Array containing runway markers positions
SICG	Mode shape deflection of CG
SIMAIN	Mode shape deflection at main landing gear
SINOSE	Mode shape deflection at nose landing gear
SIPS	Mode shape deflection at pilot station
SITAIL	Mode shape deflection at tail station
SITE	Location of runway
SLM	Distance from CL of main gear axle to CG of aircraft with strut fully extended
SLN	Distance from CL of nose gear axle to CG of aircraft with strut fully extended
SLP	Overall slope of runway profile
SPEED	Initial speed of aircraft
SSPLOT	Array of velocity of aircraft for Calcomp plot
STORE1	Temporary storage space for CG accelerations
STORE2	Temporary storage space for CG accelerations
STORE3	Temporary storage space for pilot station accelerations
STORE4	Temporary storage space for pilot station accelerations
STROKM	Array of strut stroke values corresponding to metering pin values (PINDM), main gear
STROKN	Array of strut stroke values corresponding to metering pin values (PINDN), nose gear
SXM	Number of main gear struts
SXN	Number of nose gear struts
TAILAC	Acceleration at tail station
TAILRM	Distance from tail station to CG
TAKOFF	Rotation velocity of aircraft

SYMBOL	DEFINITION
THRUST	Total thrust of aircraft
TIME	Array of simulation times at which CG acceleration time history points are stored
TIMEX	Counter variable for printed output
TIME1	Array of simulation times at which pilot station time history are stored
TSM	Tire spring constant, main gear
TSN	Tire spring constant, nose gear
TYPRUN	Defines simulation as takeoff or taxi
VOM	Main gear strut fully extended volume
VON	Nose gear strut fully extended volume
W	Weight of aircraft
WM	Main gear unsprung weight
WN	Nose gear unsprung weight
X	Simulation time
XLONG	Length of time axis for Calcomp plot
XLONG2	XLONG/2
XPROF	Location for printing of "NOSE GEAR TRACK" on Calcomp plot
XSTOP	XLONG+5
YP	Array containing runway segment elevation points and slope from end of previous segment, rear main gear
YPR	Array containing runway segment elevation points and slope from end of previous segment, rear main gear (Class E simulation only)
YPN	Array containing runway segment elevation points and slope from end of previous segment, nose gear
ZRDOT	Slope of runway segment at end point, rear main gear (Class E simulation only)

SYMBOL	DEFINITION
ZNDOT	Slope of runway segment at end point, nose gear
TAYLOR	
AOM	Net orifice area, main gear (OAM-metering pin area)
AON	Net orifice area, nose gear (OAN-metering pin area)
*BSN	Nose landing gear minimum bearing separations
*BSM	Main landing gear minimum bearing separations
COM	Damping coefficient, main gear
CON	Damping coefficient, nose gear
DRAGA	Aerodynamic drag
DRAGT	Rolling Drag
*FFON	Nose landing gear seal friction
*FFOM	Main landing gear seal friction
*FLN	Nose landing gear lower friction force
*FLM	Main landing gear lower friction force
FSM	Total force in all main gear struts
FSN	Total force in all nose gear struts
FSTN	Net force on secondary piston, nose gear (Class E simulation only)
FST1	Net force on secondary piston, rear main gear (Class E simulation only)
FST2	Net force on secondary piston, front main gear (Class E simulation only)
FTM	Force in tires, main gear
FTN	Force in tires, nose gear
*FUN	Nose landing gear upper friction force
*FUM	Main landing gear upper friction force

*Class B simulation with Strut Friction only

SYMBOL	DEFINITION
*OFFN	Nose landing gear axle offset
*OFFM	Main landing gear axle offset
*PHIN	Nose landing gear angle from the vertical
*PHIM	Main landing gear angle from the vertical
*PLN	Nose landing gear piston length
*PLM	Main landing gear piston length
QTDM	Total velocity due to flexible modes at main gear
QTDN	Total velocity due to flexible modes at nose gear
QTM	Total deflection due to flexible modes at main gear
QTN	Total deflection due to flexible modes at nose gear
SLOPEM	Slope of line drawn through two metering pin points, main gear
SLOPEN	Slope of line drawn through two metering pin points, nose gear
SSM	Pneumatic force, main gear
SSN	Pneumatic force, nose gear
T(2)	CG vertical displacement
T(4)	Unsprung mass vertical displacement, front main gear
T(6)	Unsprung mass vertical displacement, nose gear
T(8)	Rigid body pitch angle of aircraft
T(10)	Horizontal distance of aircraft
T(12)	Unsprung mass vertical displacement, rear main gear (Class E simulation only)
TD(2)	Time derivative of T(2)
TD(4)	Time derivative of T(4)
TD(6)	Time derivative of T(6)
TD(8)	Time derivative of T(8)

*Class B simulation with Strut Friction only

SYMBOL	DEFINITION
TD(10)	Time derivative of T(10)
TD(12)	Time derivative of T(12) (Class E simulation only)
TDD(2)	Time derivative of TD(2)
TDD(4)	Time derivative of TD(4)
TDD(6)	Time derivative of TD(6)
TDD(8)	Time derivative of TD(8)
TDD(10)	Time derivative of TD(10)
TDD(12)	Time derivative of TD(12) (Class E simulation only)
VELM	Total strut velocity, main gear
VELN	Total strut velocity, nose gear
VLIFT	Aerodynamic lift force
XMAIN	Strut stroke, main gear
XMLK	Absolute value of XMAIN
XNLK	Absolute value of XNOSE
XNOSE	Strut stroke, main gear
YCEPN	Y intercept of line drawn through two metering pin points, nose gear
Z	Distance of aircraft from beginning of a 4 ft runway segment
ZPM	Runway elevation, rear main gear
ZPMR	Runway elevation, front main gear (Class E simulation only)
ZPN	Runway elevation, nose gear
IC	
RM	Static reaction force at main gear
RM1T	Static reaction force at rear main gear (Class E simulation only)
RM2T	Static reaction force at front main gear (Class E simulation only)

SYMBOL	DEFINITION
RN	Static reaction force at nose gear
RSM	RM - WM
RSN	RN - WN
THETAI	Rigid body initial pitch angle
XRMAIN	Test variable for rigid body initial conditions (Class E simulation only)
ZCGI	Initial CG vertical displacement
ZMI	Initial tire deflection, main gear
ZNI	Initial tire deflection, nose gear
COEFF	
A	Coefficient of polynomial fit to runway profile segment
B	Coefficient of polynomial fit to runway profile segment
C	Coefficient of polynomial fit to runway profile segment
D	Coefficient of polynomial fit to runway profile segment
Y	Runway profile elevation value
TLOOK	
I	Index variable
N	Number of values in metering pin - stroke table
P	Metering pin diameter or net orifice area for aircraft with metering tubes or flutted metering pins
S	Strut stroke in metering pin table
SLOPE	Slope of line drawn between two metering pin points
YCEPT	Y intercept of line drawn between two metering pin points

APPENDIX E

TYPICAL WIDE BODIED TRI-JET TRANSPORT DATA AND SIMULATIONS

This appendix contains data obtained late in the study which represents a "TYPICAL" Wide Bodied Tri-Jet Transport and may be used to simulate Class C and D aircraft of this type. This appendix also contains takeoff simulations over the Will Rogers and Dulles Profiles.

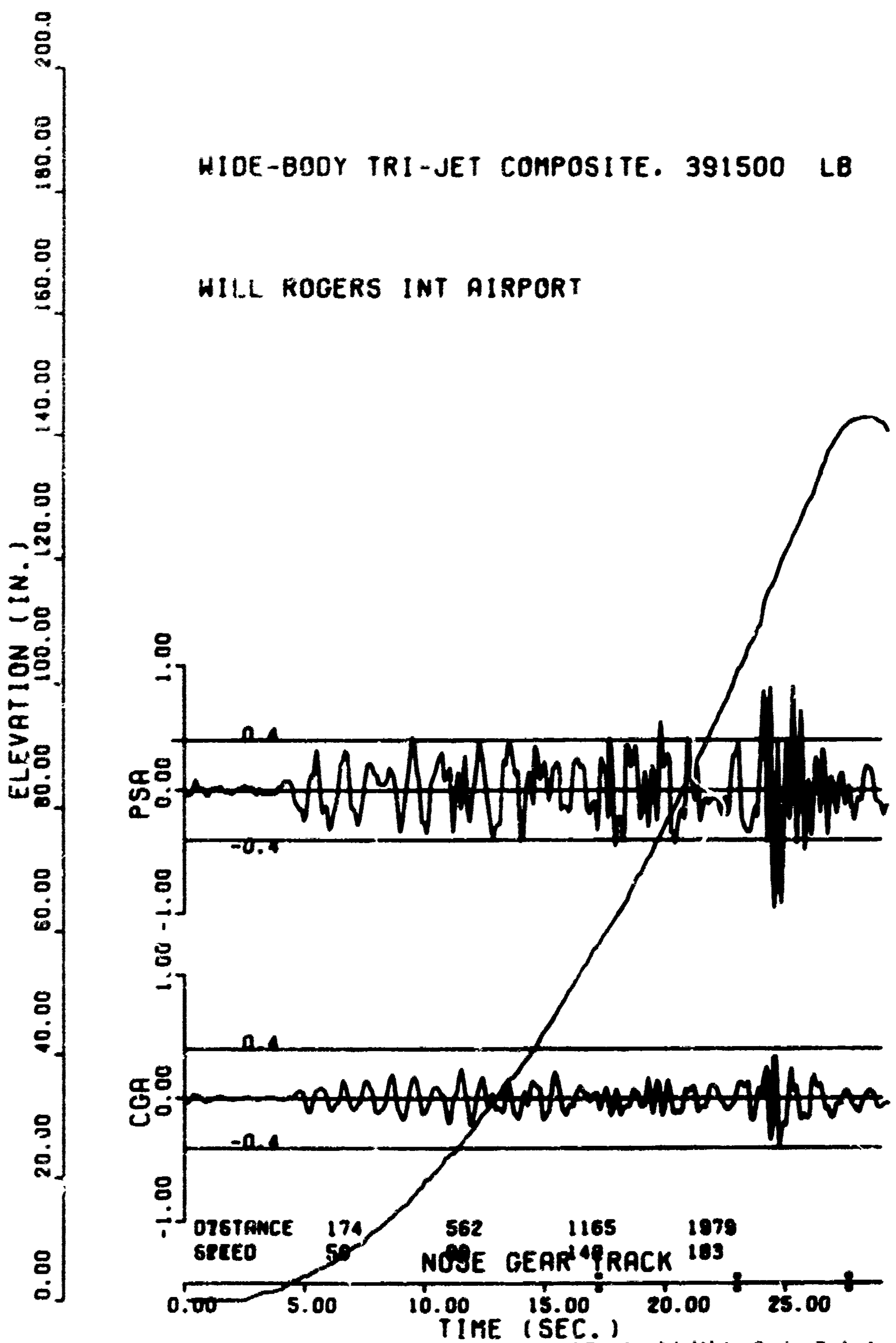


Figure 35. Plotted Results of a "Typical" Wide Body Tri-Jet Transport Taking Off from the Dulles Profile

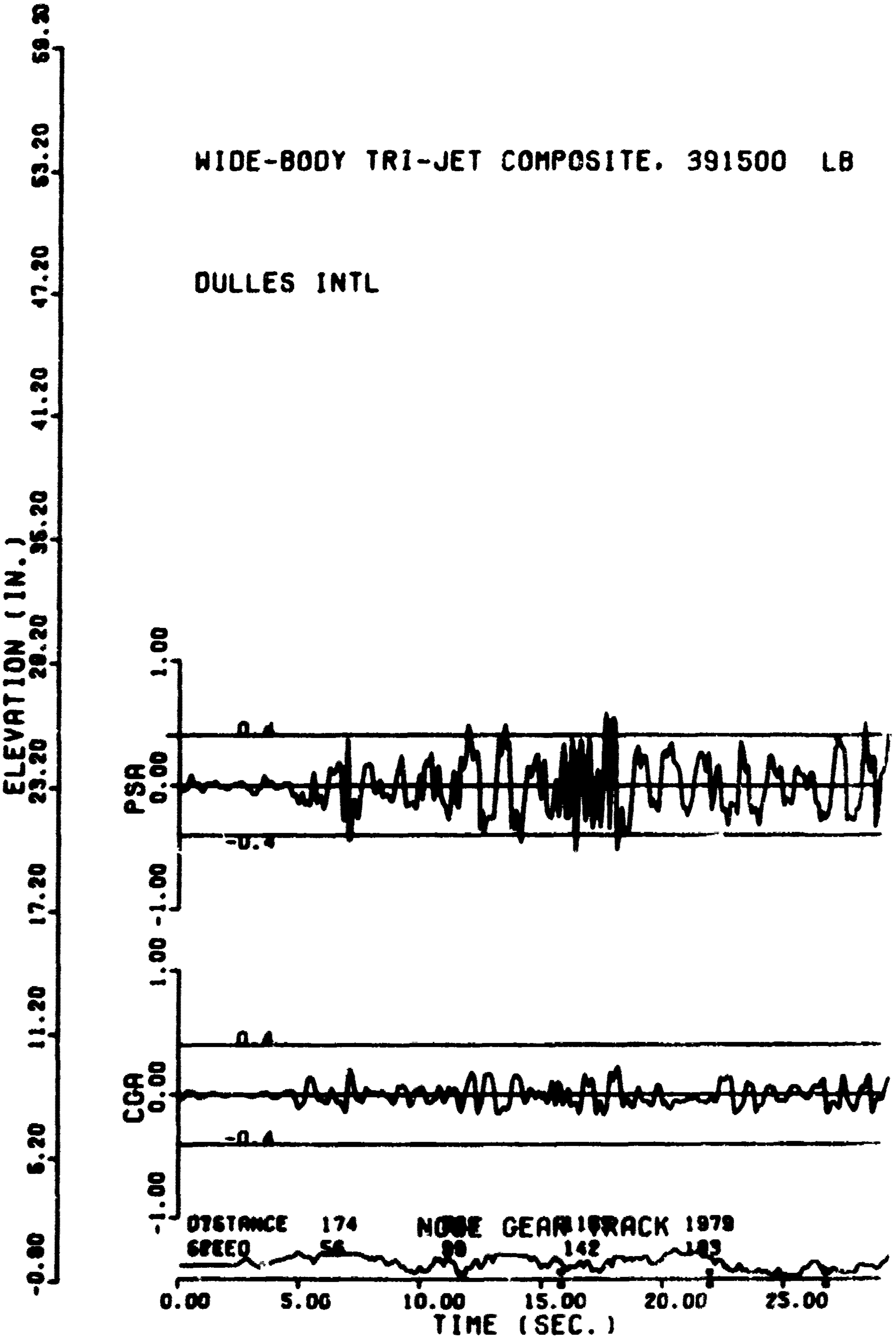


Figure 36. Plotted Results of a "Typical" Wide Body Tri-Jet Transport Taking Off from the Dulles Profile

TABLE XVII. List of Data Used to Simulate the Wide-Body Tri-Jet Composite

**************** INPUT DATA ****************

********** GENERAL AIRCRAFT DATA **********

WIDE-BODY TRI-JET COMPOSITE, 331500 LBS.

W= 331500.0	WM= 5000.00	WN= 590.00	A= 69.000	B= 787.000	MMI= 190000000.
SXM= 2.0	SXN= 1.0	S_M= 183.0	S_N= 179.0	PSARM= 1035.0	TAILRM= 508.0
AAM= 100.00	AMM= 84.00	PADM= 300.00	VOM= 2690.00	OAM= 2.09	TSM = 55000.00
AAN= 33.00	AMN= 26.40	PADN= 151.50	VON= 597.30	OAN= .57	TSN = 20000.00
CL= .220	CD= .070	AREA= 3500.00	SPEED= 2.5	THRUST=119000.	TAKOFF= 249.00

STROKE NOSE	PIN DIAMETER
0.000	0.000
10.000	.654
17.500	.752
50.000	.752

STROKE MAIN	PIN DIAMETER
0.000	0.000
15.000	1.200
25.000	1.200
50.000	1.200

TABLE XVII - Continued

MODE	SIPS	SINOSE	SICG	SIMAIN	SITAIL	OMEGA	GEN. MASS
1	-.17	-.25	-.50	-.25	-.93	7.63	2000.0
2	-.84	-.59	-.09	-.07	-.13	12.93	2000.0
3	2.52	1.58	-.23	-.49	.50	15.10	2000.0
4	2.15	1.13	-1.01	1.25	.88	18.19	2000.0
5	.53	.17	-.47	-.13	-.19	22.37	2000.0
6	-1.54	-.54	.96	-.05	.53	25.19	2000.0
7	.39	.10	-.35	.89	-.38	27.34	2000.0
8	-1.24	-.42	.41	.15	-.72	29.17	2000.0
9	1.93	.53	.31	.45	1.39	35.95	2000.0
10	-.72	-.15	.15	1.41	-1.25	39.26	2000.0
11	1.47	.15	-.54	.13	.40	39.96	2000.0
12	2.75	-.04	.37	.47	.55	47.73	2000.0
13	.62	0.00	-.27	1.52	-.19	52.27	2000.0
14	-3.15	.74	-1.22	-1.03	1.59	61.98	2000.0
15	.94	-.13	.94	-1.35	-1.24	71.36	2000.0

********* INITIAL CONDITIONS ************

ZMI= -3.276 ZNI= -1.557 THETAI= -.010282 ZCGI= -24.787

XMAIN= -22.210 XNOSE= -13.139 REACTN= -31137. REACTM= -360363.